SCIENTIFIC AMERICAN SUPPLEMENT. No. 1541

Entered at the Post Office of New York, N. Y., as Second Class Matter. Copyright, 1905, by Munn & Co.

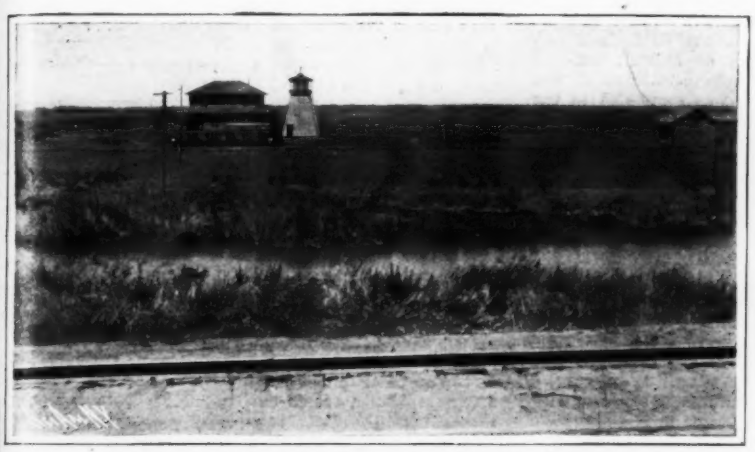
Scientific American, established 1845.
Scientific American Supplement, Vol. LX., No. 1541. NEW YORK, JULY 15, 1905. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

EXTENDING THE SANTA FE RAILROAD INTO SAN FRANCISCO.*

By HERBERT I. BENNETT.

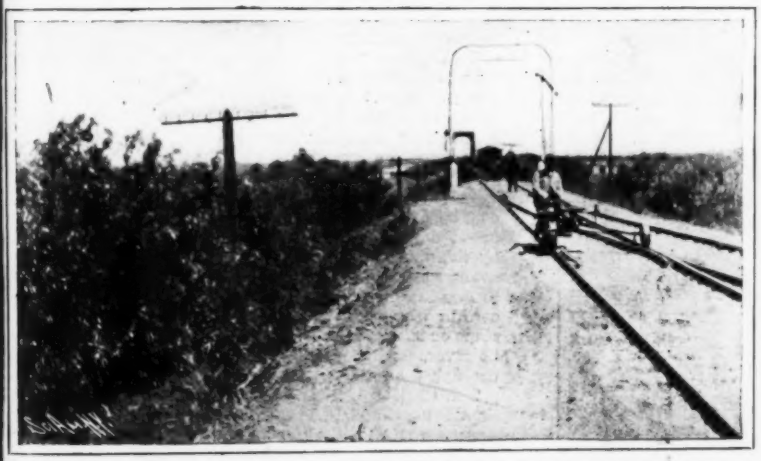
AMONG the most unique and interesting pieces of railroad construction to be found anywhere, is that portion of the Atchison, Topeka & Santa Fé Railway between Stockton and San Francisco in California, or particularly between the stations of Holt and Bixler on the division in question. Between these two stations the railroad crosses the tule swamps of the San Joaquin River and tributaries for about ten miles, and the roadbed was constructed in a peculiar and original manner to conform to the soft ground and sliding soil, which abounds in this soggy and swampy land. The engineers, when building the railroad, knowing that the ordinary rock and dirt ballast would fail utterly in such a region, decided upon putting down an embankment of peat and decayed tule grass, and accordingly this method of track construction was carried out with success. The Stockton and Point Richmond line was built by the San Francisco & San Joaquin Valley Railway, just prior to its becoming a Santa Fé Route property. Point Richmond is the rail terminus of the Santa Fé line on San Francisco Bay, from which point passengers are transported across the bay on ferryboats to the metropolis of California, the water distance being eight miles. In order to make the railroad embankment over the ten-mile stretch between Holt and Bixler, it was necessary to employ several large dredgers, which were operated day and night for more than a year, and it was in connection with the dredgers that some pioneer and extraordinary labor was introduced in railroad building. These machines literally cut their way through the tules from Middle River to Holt,

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.



FARMHOUSE ON RECLAIMED TULE LAND. FOREGROUND SHOWS SANTA FÉ PEAT ROADBED COVERED WITH BERMUDA GRASS, ALSO WATERWAY CUT BY DREDGERS DURING CONSTRUCTION OF THE LINE.

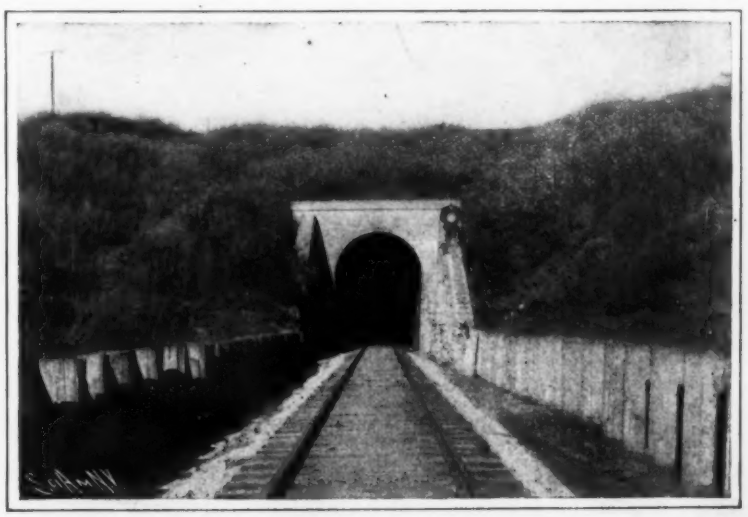
WEST APPROACH TO TWO-MILE TRESTLE WHICH FORMS PART OF THE PEAT RAILROAD EMBANKMENT. TRESTLE WITH TWO DRAWBRIDGES RUNS ENTIRE DISTANCE BETWEEN ORWOOD AND MIDDLE RIVER STATIONS ON THE SAN JOAQUIN RIVER.



WEST APPROACH TO TWO-MILE TRESTLE AND DOUBLE DRAWBRIDGE BETWEEN ORWOOD AND MIDDLE RIVER STATIONS. PEAT ROADBED.

THE ALHAMBRA VIADUCT, 1,600 FEET LONG, 75 FEET HIGH. LOOKING EAST.

PEAT ROADBED BETWEEN HOLT AND BIXLER. YOUNG WILLOW TREES AND BERMUDA GRASS ON EITHER SIDE OF TRACK. DREDGER CHANNEL ON RIGHT.

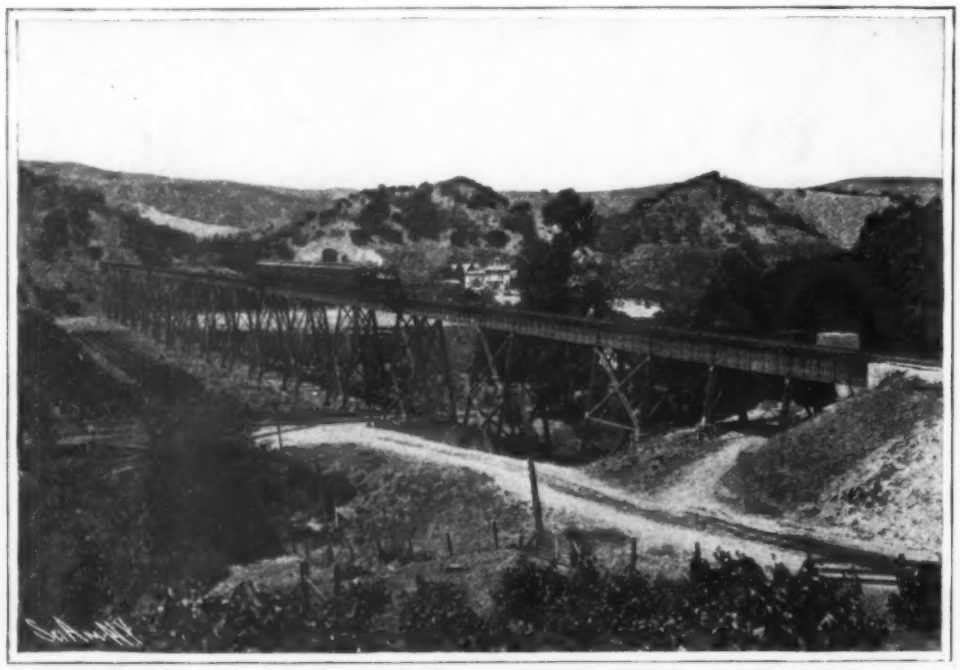


THE ENTRANCE TO THE 300-FOOT TUNNEL.

EXTENDING THE SANTA FÉ RAILROAD INTO SAN FRANCISCO.

working either side of the surveyed railroad right-of-way, and leaving broad water channels in their wake. The dredgers were clamshell devices that threw the peat up at the rate of about four hundred thousand yards to the mile, except in places where the embankment slid out, where a great deal more peat was required to establish solidity. The peat was applied in layers, and allowed to become thoroughly dry and hardened before the next application of embankment material was made, and it is surprising what a firm roadbed has been made of this decayed peat and grass, which carries the track across the most difficult character of ground for a railroad to get over. When Chief Engineer W. B. Storey, of the San Francisco & San Joaquin Valley Railway, expressed his intention to carry out this peat embankment construction, the idea was given little credence by engineers, but Mr. Storey went ahead and proved the efficacy of his plan, besides establishing an important new epoch in railway engineering in tule and marshy lands, where the quicksands swallow up rock and earth almost as fast as they can be dumped into place. Mr. Storey is now chief engineer of the Atchison, Topeka & Santa Fé Railway from Chicago to Albuquerque, with headquarters at Topeka, Kan. This is said to be the only piece of peat railroad embankment in the world at the present time. The base of rail is about thirty-five feet above solid clay base, upon which the embankment rests, and the ballast under the track is of coarse gravel from the Santa Fé's Stanislaus River gravel pits. The ballast is about twelve inches thick under the ties, and the rails are seventy-five pounds per yard. In order to guard against the sliding of the peat, the planting of willow trees on both sides of the embankment was resorted to, as the roots mat and tend to hold everything intact, besides effectually preventing damage from wave wash in the event of floods in this low-lying district. There has also been planted between the track and the willows Bermuda grass, which is a very tough salt grass that grows about six or ten inches high and mats into practically a solid mass, thus acting as a powerful medium for maintaining solidity along the peat roadbed. Not a little trouble has been encountered with fires in the tule lands, and the vegetation on the railroad embankment being dry causes it to burn readily, and it has required as long as three and four days to extinguish the smoldering blaze under the track at times; it sometimes appears to be all out, but perhaps the next day will find the fire springing out afresh. In order to eliminate this annoyance, the Santa Fé engineers have decided upon covering the entire embankment with a layer of gravel about twelve inches deep, and it is believed that this will prevent fires from working into the peat right-of-way from the surface. The new experiment is now being put into practice along the track between Holt and Bixler. A valuable fact regarding the Santa Fé track embankment through the tule region of the San Joaquin River, is that it acts as a levee, and the levees on reclaimed lands running at right angles to the railroad, are built up against the peat railroad track embankment. The railroad has opened thousands of acres of land now under cultivation, and pumps are employed to keep the water down to a proper level. Prior to the advent of the Santa Fé route, this land was entirely a tule marsh, but it is gradually coming under cultivation, and asparagus and other garden truck can be seen thriving, where the tule formerly reigned supreme. Between Point Richmond and Bay Point there are five tunnels and a great steel viaduct, the latter spanning the narrow and beautiful Alhambra Valley, situated in the Mount Diablo foothills, about 28 miles easterly from San Francisco. The Alhambra viaduct is sixteen hundred feet long, seventy-five feet high, and is built of steel supported on towers resting upon concrete piers, and crosses above orchards and vineyards of picturesque aspect. Of the tunnels, the Franklin is the longest of the group, being 5,680 feet, or over a mile in length. This tunnel is built on a tangent, and passes through a soft stratum of earth, between a blue clay and soft rock, which had a tendency to swell when first exposed to the air; and when the railroad was first built through it, the crushed timbering had to be removed two or three times until the swelling ceased. The Franklin tunnel is now solid throughout its entire length, and it pierces the Franklin hills twenty-five miles from San Francisco. The seventy miles of difficult railroad building between Stockton and Point Richmond was begun in the fall of 1898, and was completed in the spring of 1900. The foregoing data were furnished by Mr. E. F. Henderson, resident engineer of the Valley Division of the Atchison, Topeka & Santa Fé Railway, with headquarters at Oakland, Cal., who also furnished the writer with a motor railroad vehicle, in order to procure desired photographs along the road described.

PEAT EMBANKMENT OF SANTA FÉ RAILROAD, SHOWING CHANNEL CUT BY DREDGERS.



THE 1,600-FOOT VIADUCT ACROSS THE ALHAMBRA VALLEY, CONTRA COSTA COUNTY, CAL. AT THE END OF THE STRUCTURE APPEARS THE 300-FOOT TUNNEL.

EXTENDING THE SANTA FÉ RAILROAD INTO SAN FRANCISCO.

THEATRICAL ENGINEERING PAST AND PRESENT.*

THE dramatic compositions of every age, in so far as they were intended to be represented at all, have always stood in necessary relation to the stage equipment of their epochs. This was the case with the dramas of the Romans and Greeks, with the mysteries and passion plays of the Christian middle age, and with the culmination of the English drama in Shakespeare's time, and it is the case with the drama of to-day.

Even the old Greek theaters had a great variety of hoisting and suspending apparatus, and the old church plays and mysteries had effective scenery. The theaters of Shakespeare's time, on the other hand, appear to have possessed little or no scenic equipment. The opera grew out of the pastoral plays given at the theater of the Italian court. Theatrical pomp originated there, spread thence to Spain and the Netherlands, and, gradually, effective scenic illusion found its way to Germany.

The structure of a play, its dramatic composition and theatrical form, proceed naturally from the picture of the nature of the stage which the author has in his mind's eye. It is therefore not only necessary to the proper understanding of dramatic compositions of various epochs to study the stage arrangements out of which they grew, but the consideration of the gradual development of our scenic theater will lead us to interesting conclusions in regard to the gain resulting from scenic changes continued for a long period, and also to the gradual loss of certain old and effective arrangements.

Although we shall confine our attention chiefly to the conditions which have prevailed in the German theater, we shall be obliged to glance at the development of the scenic art in other countries, in so far as it has exerted a clearly recognizable influence upon us. Such influence has been chiefly, and strongly, exerted, at divers times and in divers ways, by the Italian and English theaters.

The theater of the Greeks and Romans lies outside the purpose of our sketch. In the middle ages, when the true Christian popular theater began to develop in Germany from the public religious-theatrical exhibitions, not a trace of the peculiarities of the ancient stage passed over to it. The break with the heathen past was so complete, that even the theater of the medieval passion plays at first developed quite independently from the Christian church, and had to go through a new infancy before it could be educated into artistic forms. Not until a later period in the history of the modern theater did certain fundamental principles of the ancient stage make themselves felt, and then only transiently and in much disguised form, because of the essential difference of the conditions.

As is well known, the ground plan of the ancient theater was a circle, more than half of which was surrounded by the spectators' seats. The stage proper, that is, the raised platform at the back, was broad but of little depth, because only a few personages appeared in any scene. Exits and entrances were made through three doorways in the temple-like structure which formed the back of the stage.

That the ancient theater did not, as some have asserted, make use of plastic and graphic decoration in the modern sense of realistic illusion, is evident from the general construction of the stage and from the circumstance that the performances took place by daylight, for it is well known that scenic illusion cannot be produced without the aid of artificial light. In many tragedies the dignified architecture of the stage building, adorned with columns and statues, was suited, in itself, for the representation of the scene of action and it needed, therefore, no further indication of place given by scenery. When the stage had to represent a forest, a cliff, a tent, a street, etc., such indications must suffice as were given by pieces of scenery attached to the front of the building. The Greek stage also possessed a scenic device, analogous to our side scenes, in the *periacts*, large triangular columns, with various scenes painted on their faces, which, mounted on pivots at the sides of the stage, near the *parascenes*, could be turned to represent three different scenes. For even in ancient plays, such as the "Eumenides" of Aeschylus and the "Ajax" of Sophocles, visible changes of scene were required. There is no doubt that the ancient stage had an upper and a lower story, which, moreover, were made necessary by the requirements of the ancient dramas.

Pollux mentions the *géranos*, a crane or hoist, by means of which, for example, the theft of the body of Memnon by Eros was effected, as well as the swings or suspension apparatus by which aerial flights of gods and heroes across the stage were managed. The assertion of Pollux, that the machinery by which sudden apparitions of deities were produced was placed, not in the middle but at the left *parascene*, is explained by the small depth of the stage, which compelled the actors to seek in its width a proper distance from which to regard and address the hovering divinity. It is not certain whether the curtain was used on the Athenian stage or is a Roman invention. It is generally assumed, however, that it was not lowered, but rose from below through a slit in the front of the stage.

The Christian, like the Greek, stage was devoted to divine service. Its conformation grew out of the dramatic rites of the Syrian church, and hence its continual suggestions of the ancient Greek theater become easily explicable. For the earliest dramatic religious representations the stage was built in the church, facing the lofty choir. The choir gallery above served as an upper stage or loft, from which angels descended and from which also the Star of Bethlehem, the Christmas manger, and the ascending figure of Christ in the Resurrection were directed. As the ecclesiastical plays or mysteries developed, it became necessary to remove the stage from the narrow church, first to the churchyard and then to the streets. As these exhibitions were really mere tableaux, which often had to be divided into separate pictures as numerous as the moments of the sacred story which it was desired to represent, the stage was increased inordinately in width, especially in France, which even in the middle ages was the leader in theatrical development.

But as the spectators could not well view so extended a stage, three stages were arranged side by side, but inclined at obtuse angles to each other, in a field or public square, and the spectators turned from one to another at the change of scene. Stages were also mounted on wheels, particularly in London, so that the exhibition could be repeated on holidays in different quarters of the city.

The need of several stages, one above another, made itself felt in all these religious plays, as it had in the kindred Greek drama. The active relations between occurrences on earth and in heaven, the continual interaction of human and divine agencies, exacted in both cases a visible above and below. As it had been found convenient to build the stage square across the end of a street, to use the windows of the adjoining

* An address delivered before the Polytechnic Club of Munich, January 9, 1905, by Carl Lautenschlaeger, formerly director of stage machinery at the Royal Bavarian Court Theater in Munich.

houses as boxes and the pavement as a parquet, the width of the stage was limited and, in order to depict the numerous scenes which were needed, for example, in a representation of the life of Christ from his birth to his ascension, the stages had to be plied up high above each other. So it was that in a representation at Metz in 1427 the stage structure consisted of nine stories.

With the secularization of the drama in the sixteenth century, the arrangement of the stage was necessarily modified. Yet the artistic advantages offered by the upper stage were too manifest to permit it to be abandoned, and it was therefore adapted to the new requirements. In the sixteenth century in England and Germany, and still earlier in Spain and France, stages were erected in courts, usually of inns. The windows and balconies of the abutting buildings formed boxes, and the balcony which ran across the stage at the back constituted the upper stage (the English "traverse") upon which scenes were enacted which were supposed to take place on balconies, battlements, etc. Though, no doubt, a detached flight of steps led to this gallery, it was also accessible through the central entrance, corresponding to the Greek royal entrance, which the stage had never lacked. This was closed by a curtain. Tieck has thoroughly discussed the way in which these stages were utilized in the representation of Shakespeare's plays. That the stages of the first permanent theaters in Germany, which were built by the Meistersingers in Nuremberg and Augsburg in the sixteenth century, had the same arrangement is proved by the stage directions in Jacob Ayrer's plays. In all countries these tavern theaters were still used by daylight.

The stage alone was protected from the weather by a roof. In the winter theaters, constructed in halls for the purpose of giving performances by candle-light, the balcony was retained, and the ends of it which abutted on the stage probably served as an upper stage, as the traverse did in the summer theaters.

The back of the scene was closed by a large divided curtain, which could also be opened from one of the boxes, which was reserved for such purposes. But it must not be supposed that the medieval stage down to Shakespeare's time was always so empty and bare of scenic embellishments. The mysteries had scenery the illusive effect of which is celebrated in numerous chronicles. The tavern theaters and even those in which Shakespeare played may have possessed little or no scenic paraphernalia. The frequent changes of place and time in the medieval drama reckoned upon voluntary efforts of imagination by the spectators, eked out, perhaps, by signs displayed on the stage. Transformations and enchantments such as Shakespeare introduces in "The Tempest," "Cymbeline" and other plays, obviously call for stage machinery and illusive scenery. Whether the stages in the palaces of lords and kings alone were properly equipped, or the winter theater of the Shakespeare company at Blackfriars also had scenery, is unknown.

In the theaters of the Italian courts, meanwhile, the opera had been developed from the pastoral plays, and the ingenious splendors of court pageants and fairy spectacles had become firmly established on the stage. The sacred and profane dramas of Lope de Vega had demanded of the Spanish stage everything in the way of theatrical illusion that the inventive genius of the time could supply. This theatrical magnificence had been transplanted to the Netherlands by their Spanish rulers, and the Jesuit plays had extended it over Germany. Still, however, the artistic convention was not destroyed, the Attic stage had not yet ceased to be the general model of the Christian. The three entrances had expanded into three vistas of beautiful Roman architecture, whose changeable inner portions, especially in the central vista, gradually took upon themselves, more and more, the function of scenic indication of place. Nor had the upper stage, represented by the galleries and balconies, yet disappeared. The curtain, that is, the modern front curtain, which conceals the entire stage and cuts off the dramatic action, was not yet in use. In Shakespeare's time the actors entered at the beginning of each scene, and left the stage at its close; the play could neither begin nor end in the middle of a situation. The curtain covering the whole stage has removed this restriction. So that, although in the first half of the seventeenth century there were stages arranged in a great variety of ways, they all followed the pattern of the antique stage and its medieval modifications. Upon all of them still prevailed the old artistic convention, certain assumptions as to the locality and character of the scene and a voluntary agreement of the spectators to deceive their imaginations with permanent stage structures and a few scenic hints.

All this changed about the middle of the seventeenth century, when the opera, supported by abundant capital, increased the use of illusive scenery and the demand for still more realistic effects.

The corresponding inventions soon appeared. In 1657 Ferdinand Bibbienna introduced side scenes, or wings, and with them frequent changes of scene in sight of the spectators; also, the drop curtain, which facilitated other changes of scene. All the old poetical conventions, all the permanent indications of place, all need of invoking the fancy of the public to complete the illusion, ceased; thenceforth the spectator had not to imagine what he did not see. It was a thoroughly modern and rational invention, and it made of the old stage a *tabula rasa*, upon which any creation of fancy could now be brought by mechanical means from above, below, or any side, according to the need of the moment. The inventive faculty was also trained by a century of practice on the fantastically gorgeous scenery and veritable marvels of mechanism of the operas and Jesuit plays. It must be conceded that with the Italian innovations the stage obtained perfect freedom, so that it was able to appropriate every advantage of the ancient and medieval constructions that might be required in special productions, without being, in general, cramped by their rigidity.

But, as it is always more difficult to make proper use of freedom than of limitations, the stage, in general, again became content with modest and meager equipments, after creative energy had exhausted itself in its first wild outburst, and the drama had returned to the path of nature.

In the foregoing introduction I have followed Eduard Devrient and other historians of the German drama. I will now endeavor to trace, from my own observations, the developments of the past fifty years and the present day.

The opera houses that I knew fifty years ago were, presumably, not very different from those of former centuries. The scene was represented essentially by a painted curtain hung at the back of the stage—the back drop. The view was cut off above and laterally, so that the outer parts of the stage were hidden from the spectator, by lateral series of narrow painted partitions—the side scenes or wings—and narrow strips of painted canvas above—the soffits or flies. To facilitate changes of scene during the performance, the back scene and soffits were arranged to roll up, the side scenes to slide to right and left.

The divisions of the stage building differed little from those of to-day. There was a large central area, flanked usually by six or eight groups of side scenes. The wooden building had three or four stories below the stage, but above it, in contrast to the present arrangement, merely a one-story low-roofed wooden machine loft. The machinery, which filled all the space above and below the stage, was very complicated, and formed a perplexing enigma for the uninitiated.

The back scene and flies were hung on ropes which ran over rollers in the machine loft and thence to a winch in the working gallery, and could be raised and lowered by hand. In visible changes of scene, which were then customary, a train of wheels driven by a heavy weight was also employed to raise simultaneously all pieces the hand ropes of which were attached to the system. In quickly succeeding changes, such as were made in the very popular fairy extravaganzas, "The Millionaire Peasant," "The Fairy King's Diamond," etc., it was extremely difficult to wind up the weight again from the lower stage as quickly as was required, as the winches of the scenes to be raised had first to be stopped by safety brakes, and the ropes then removed from the cylinders—operations which were complicated and tedious.

The side scenes, of which usually four or five stood, one behind another, in each alley, were attached to strong wooden frames borne on carriages which were drawn, by weights and wheels, along tracks beneath the stage.

If houses, ships, trees, and the like had to be moved, they were likewise attached to the shifting carriages, but the ladder-like framework was replaced by a simple wooden upright, ending above in a narrow strip of iron, which moved in a narrow slit extending across the entire width of the stage. Detached pieces which were to be lowered were attached to "cassettes," wooden beams moved vertically between guides by a rack and pinion device on the floor below.

Other elevating devices, the traps, served to make personages vanish or rise from the ground. To each trap, of course, corresponded an opening in the stage, which was usually closed by a sliding door worked from below. To represent flying birds and to enable dancing girls to hover in the air, a traveling winch, "the flying cat," was arranged under the machine loft. This device has the honor of serving as a model for the traveling crane, now indispensable in machine shops. The mechanical apparatus for the so-called flying bridges, which made it possible to lower from above whole tableaux with scenery and dozens of fairies, angels, or flower girls, occupied a great deal of space in the machine loft and the working galleries suspended from it.

For this purpose there were provided, usually, three systems of great wooden rollers, mounted in iron bearings on wooden posts and filling the entire depth of the loft. Gigantic winches, two or three meters in diameter, enabled the counterpoised rollers to be driven by hand power. Elevations of the ground were produced by trestles and planks or "practicable" platforms and steps properly combined.

Depressions of the ground could not be represented at all. Worst of all was the illumination. Hundreds of oil lamps, even if they burned brightly (which they rarely did) threw over the great stage just enough light to make the actors recognizable, but the scenery and everything else remained in semi-obscurity—a fact not always regrettable, in view of their shabbiness.

The changes from night to day and *vice versa*, produced mechanically by interposition of screens, would now scarcely satisfy an amateur theater. But nothing better was known, and the spectators were content. It was not a rare occurrence for one or more lamp chimneys to break in the footlights right and left of the prompter's box, and for a dense black smoke to poison the atmosphere during the rest of the evening. When critical persons—for there were such even then—expressed displeasure, others reminded them of the tallow candles with which theater-goers once had to be satisfied, and of the nuisance of having snuffers performing their functions in the middle of a delicate situation.

Long before this gas had been introduced into the London theaters and, soon afterward, into those of Paris, Germany finally yielded to the pressure then exerted by Paris upon all European theaters. Meyerbeer, who even before 1850 controlled the repertory of the Paris Opera and, through it, that of the theaters of Europe, raised stage settings to a pitch of effectiveness never before known, with the aid of the new illuminant and of the pre-eminent scenic artists then attached to the Grand Opera. But when the "electric sun," invented by Prof. Lormier in 1849, was introduced in the production of "Le Prophète," the acme of the attainable seemed to have been reached, and Paris was, more than ever, the arbiter of style in the drama as in dress. The brilliant triumphs won by the Grand Opera through its fine stage setting naturally evoked prompt rivalry in Paris itself. Private or unsubsidized theaters, including the Porte Saint Martin and the Chatelet, came into existence, and surpassed the Opera with the brilliancy of their so-called fairy plays, which, though devoid of sense or reason, were so elegantly mounted and lighted that they charmed and dazzled the spectators.

At the same time the stage engineer was playing a star part in Austria and Germany, where the repertory consisted mainly of fairy extravaganzas and pantomimes, in addition to the opera. It was the golden age of the stage engineer, for the issue of success or failure hinged chiefly on his will and ability. Of the fortunate workers of that period, only a few of the most prominent are still remembered. These include the "court theatrical machinists," as they were then called, of the Vienna, Darmstadt, and Munich court theaters, Messrs. Dreilich, Dorn, and Schuetz, who were also theater constructors. Josef Muehldorfer, scene painter and machinist in Mannheim, however, first won popular fame through his original settings of "Oberon," "Der Freischuetz," "Undine," and many popular fairy plays. From every part of Baden, from Bavaria, Hesse, even from foreign countries, crowds flocked to little Mannheim to behold these scenic marvels. Muehldorfer's great success encouraged the Mannheim town council to increase his subvention, and finally to grant his request that the old Schiller theater should be rebuilt in accordance with modern ideas. This alteration, in 1853, was the first step in an important reform in stage construction.

The low stage building was raised to twice its former height, which made it possible to draw up the painted curtains without folding them in the middle, as had previously been done. The mechanism of the back scenes, which hitherto, in all theaters, had been drawn up by cords without counterpoises, was ingeniously improved by the adoption of weights running in wooden tubes on the wall, which enabled all such scenes to be mounted in advance in such a manner that during the performance one man could easily set them in motion from the stage or the working gallery.

The roof and the fixed parts of the machine loft and galleries were still made of wood, but they were arranged and subdivided on a new plan. But the most important improvements were made under the stage. The narrow lanes of side scenes and the system of shifting carriages were retained almost unchanged, but everything else was new. The small traps were abolished, except at the front of the stage, and replaced by traps running across the entire width of the stage at each of the six lanes. These permitted either single personages or large groups and tableaux to be raised or lowered through half the height of the stage. The traps were arranged to be coupled together, so that all of them could be raised or lowered at once. The wooden flooring and posts between the traps could also be removed, so that, when two traps were connected by a movable floor, they formed a firm platform two or three lanes in depth, which could be raised two meters above the level of the stage or depressed to an equal distance below it. These novel stage arrangements were completed by the addition of gas, which enabled the illumination of every part of the stage to be regulated and graduated from a single point, merely by turning cocks in the so-called regulator, from which all the gas pipes radiated. That Muehldorfer, in possession of the best appliances then known, would undertake the presentation of Meyerbeer's operas, "Robert le Diable," "Le Prophète," and "Le Pardon de Ploermel" ("Dinorah"), in the most sumptuous fashion and, if possible, would surpass the Parisians, had been the expectation of his friends in the town council, and they were not disappointed. The concourse to Mannheim steadily increased. The news of Muehldorfer's success reached Paris, and Meyerbeer himself came to see his own works performed in Mannheim. "Spoiled" though he was by the Parisian productions, he was so charmed by Muehldorfer's original setting that he warmly recommended him to the directors of the Paris Opera, for the staging of new works.

Meanwhile, in Darmstadt, where the court theater had long been noted for its effective stage settings, a dangerous rival had arisen in the person of the newly engaged "machinist," Carl Brandt, who, despite the antiquated apparatus at his disposal, applied his genius and his study of the Paris spectacles and their lighting effects to productions of "Nebuchadnezzar," "The Vampire," "The Prodigal," and Spohr's "Faust," which won universal applause and attracted many visitors from neighboring cities. The Meyerbeer operas and the grand ballets, for which Brandt had constructed a sub-stage and introduced gaslight, intensified the rivalry between Mannheim and Darmstadt, and Gounod's "Faust," which, immediately after its production in Paris, was given in Darmstadt in the most magnificent style, drew throngs from near and far to the little capital. (To be continued.)

THE SCHLICK PALLOGRAPH.*

By Dr. ALFRED GRADENWITZ.

IT is a well-known fact that steamers will perform vibrations of a magnitude that depends on the design and location of the engines. Mr. Otto Schlick, of Hamburg, has formulated some valuable rules for the construction and arrangement of marine engines calculated to minimize these vibrations, and it is mainly due to his investigations that modern transatlantic steamers may sail at speeds up to 24 knots.

In order better to ascertain these conditions on a given steamer, Mr. Schlick has invented what he calls a "pallograph," that is, an apparatus for measuring and registering the vibrations, which instrument is constructed by H. Maihak, of Hamburg.

The four parts of the instrument are intended for the following purposes: First, measuring the vertical; second, the horizontal vibrations; third, driving the recording strip; and, fourth, marking the position of the crank of the engine.

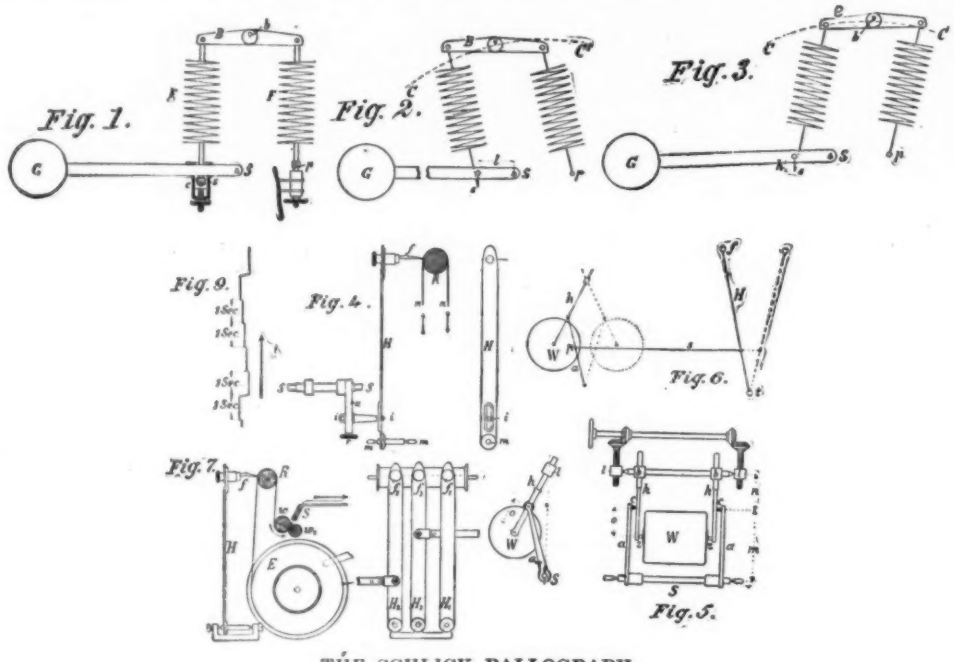
The device for measuring the vertical vibrations, as represented in Figs. 1 and 2, consists mainly of a horizontal forked lever which rests on fine steel knife bearing at the point, *S*, and which carries a heavy weight, *G*, at its other end. By means of two coiled springs, *F* and F_1, which are coupled together by means of a steelyard, *B*, the weight is kept in a horizontal position. The knife edge, *s*, rests in a casing, *c*, on the lever; in drawing the lever upward, the spring, *F*, acts chiefly on this knife edge, while the other spring, F_1, is fixed at *p* by an adjusting screw.

Now suppose this system to be installed on a vessel. As soon as any vibrations are set up in the ship, the weight, *G*, will tend by virtue of its inertia to remain at rest, while appearing to move in a direction opposite to the direction of the vibrations, that is to say, it will appear to move upward in the case of a downward movement of the whole system, and *vice versa*, though in reality it remains at rest in both cases. If now a vertical impulse be given to the weight, the system begins to vibrate in a certain period. Care should be taken that this period be different from that of the vibrations of the ship, lest the weight be set vibrating as soon as the craft begins swinging up and down. For this purpose a regulating arrangement has been provided for shifting the point of suspension, *b*, of the steelyard sideways along a curved path, $C C_1$. In the position shown in Fig. 2 the period of oscillation will be shortened, while in the position of Fig. 3 the period is lengthened. On a scale placed alongside $C C_1$, the number of oscillations is read off immediately. The distance, *h*, of the point, *S*, from the axis of the lever and the horizontal distance, *l*, of *s* from the turning point, *S*, can be adjusted.

On one side of the axis, *S*, of the lever (Fig. 4) a small arm, *a*, projecting downward has been provided, holding a small horizontal pin, *i i*, which can be shifted in a vertical direction by means of the adjusting screw, *r*. This pin acts on the slot in the vertical lever, *H*, which at its upper end holds the recording pen while rotating at its lower end round the axis, *m m*. If the weight, *G*, move up and down, the lever, *H*, will obviously be moved backward and forward by means of the pin, *i*, so that the recording pen, *f*, is allowed to mark the vertical oscillations of the weight, *G*, on the strip of paper, *n*, traveling over the roller, *R*. By adjusting the pin the oscillations of the weight, *G*, can be made to coincide exactly with the path of the pen, *f*.

b b, are mounted on a horizontal shaft which rests in bearings at *l l*. The latter can be moved up and down by means of two vertical screws which are connected by a pair of bevel gears, and a small shaft, so that the distance, *m*, can be altered within certain limits.

The mutual ratio between the lengths, *n*, *m*, *o* when the sleeves *b b* are in their uppermost position, is such that the weight, *W*, moves with its center of gravity



THE SCHLICK PALLOGRAPH.

almost in a straight horizontal line. If the sleeves be brought into the lower position, the weight moves in an arc of a circle about 5 feet 3 inches in radius, when the period of oscillation is about 1½ seconds. By adjusting the bearings, *l l*, the period of oscillation of the pendulum can be regulated conveniently. The pin, *p*, on the guide bar, *a*, serves to transmit the motion of the pendulum by means of a light rod, *s* (Fig. 6), to the tracing lever, *H*, which has its turning point at *t*, and at its upper end bears the tracing pen, *f*.

Any side movement of the bed on which the instrument rests will apparently cause the pendulum to perform oscillations between the dotted and full line positions shown in the figure while imparting movements with that of the pen.

The projecting pin, *p*, can be moved by means of a small slide, adjusting the proportion between the respective amounts of travel of the lever and pen, *f*, in such a manner that the part described by the pen is exactly as great as the one described by the weight, *W*.

In Fig. 7 is shown the device which propels the recording strip, which is four inches in width and 328 feet in length, and is wound on a hollow cardboard

The tracing pens, f_1, f_2, and f_3 (Figs. 7 and 8), which are fitted to the upper ends of the levers, H_1, H_2, and H_3, are situated at the point where the strip is caught by the roller, *R*. The lever, H_1, traces the vertical oscillations and the lever, H_2, the horizontal oscillations, while the lever, H_3, is actuated by the clockwork in such a manner that it moves about 1-16 inch to the right during each second and springs back again after

THE SCHLICK PALLOGRAPH.

The outfit for measuring the horizontal vibrations consists mainly of a pendulum weight, suspended by means of a special mechanism. The cylindrical weight, *W* (Fig. 5), is suspended from a pair of sleeves, *b b*. The two vertical rods, *h h*, supporting the horizontal axis, *z z*, of this weight are borne by a pair of pins *c c*, at the upper end of the two lever arms, *a a*, which latter are again attached to a shaft, *S*. The two sleeves

cylinder which is slipped on a roller fitted at both sides with circular brass plate disks against which two springs are made to press, so that the strip unwinds under a constant gentle pressure.

The strip unwinds from the drum, *E*, over the guide-roller, *R*, to the driving-roller, *w*, and the presser roller, w_1, being guided by *S*, and then comes out free. The roller, *w*, is driven in the direction indicated by the arrow.

every fifth second. The figure thus drawn on the strip has the appearance shown in Fig. 9.

The tracing pens should be exactly in the same straight line at right angles to the direction of motion of the strip. The arrangement for adjusting them to this position is shown in Fig. 10. Through the two vertical slots, *a a*, at the upper end of each lever pass the attaching screws for the slide. The tracing pen passes through the oval-shaped opening, *b*. The lever, *H*, has a round hole, *d*, which lies opposite the horizontal slot, *c*, in the slide, *s s*. After easing slightly the screws at *a a*, a key, k_1 (see Fig. 11) having a round end that exactly fits into the round hole, *d*, and is provided with a small eccentrical projecting pin, is inserted in the hole, *d*, so that the eccentric pin takes hold of the slot, *c*. By means of a slight turn of the key the side can be moved upward or downward into position.

In Fig. 12 the propelling machinery and the clockwork are shown; the former is arranged on one side of the guide roller, *R*, and is regulated by a fan. The transmission of the motion to the roller, *R*, is effected by means of differential gearing having two different speeds. On the other side of the guide roller is arranged the seconds clock train, *U*, which is thrown out of gear by the clock train after one second has elapsed, while a wheel provided with teeth similar to those of a ratchet is turned through a small angle, thus slightly raising a lever which is coupled by means of a light rod with the lever, H_3, in Fig. 8. The tracing pen, f_3, is thus enabled to describe the stepped line above referred to for marking the time. When the plate, *p*, seen in Fig. 13, is in the vertical position both the propelling machinery and seconds work are thrown into gear. By throwing over the small crank, *k*, the plate, *p*, is brought into the horizontal position (see Fig. 14) and pushes the tracing lever a little to the side so that the pens no longer bear against the recording strip, while at the same time the motion of the propelling and seconds marking machinery is stopped.

Now, as to the tracing device for marking the position of the crank above the guide roller, *R* (see Figs. 14 and 15), a frame is arranged in which two small horizontal electro-magnets, *e e*, are fitted. In the middle of the frame, lying close together, are the two pallets, *a a* (Fig. 15), slipped on a small pin, *c*, so as to turn about a horizontal axis. An arm, *b*, attached at the lower side of each of these pallets will describe at a point exactly opposite the position of the tracing pen the required marks on the strip, by means of a pen, *i*, fixed to its lower end. As soon as an electric current passes through the coils of one of the magnets, the corresponding pallet is drawn up, turning through a small angle on the pin, *c*, and causing the arm, *b*, which holds the corresponding tracing pen, to be moved slightly aside.

The required electric contact is produced in the following manner: To each tunnel shaft is attached a wooden disk of suitable diameter and about 3½ to 4 inches (80 to 100 millimeters) in thickness. The disk must be made in two parts to enable it to be fitted to the shaft at any suitable position. Over the part of the periphery, *a b*, in Fig. 16, a strip of brass is inserted, which by means of a wire or strip of metal is brought into electric contact with the shaft. Bearing on the periphery is a spring in the form of an insulated brass strip, *F*, which is connected with the electromagnet by means of a conducting wire. In this conducting wire several galvanic elements, as constant as possible in their action, must be inserted. The return lead from

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

the electromagnet may be attached to any metallic part of the vessel's hull. At the points *a* and *b* of the contact disk it is desirable to form a groove about 1-16 inch (1½ millimeters) in breadth, in order to prevent a contact from being established with the periphery of the disk, which through the metal spring trailing over it may easily become conductive.

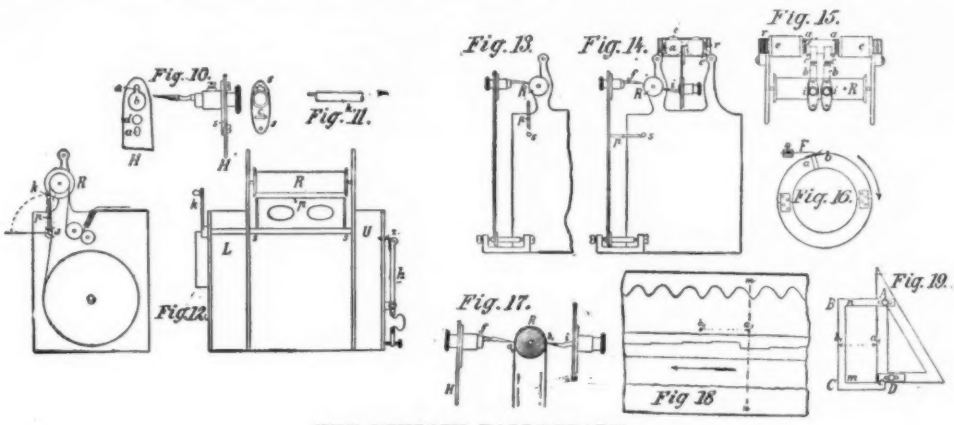
When the shaft revolves, the electric contact will, during the time in which the metallic part of the periphery, *a b*, bears against the spring, *F*, be established, and the tracing pen, *f*, in Fig. 15 describes the required marks on the recording strip. The length of the contact strip, *a b* (Fig. 16), should be so regulated that the contact may be established for at least 1/10 of a second. In the case of very fast-running engines it becomes necessary to resort to gearing in order that the contact disk may make only half as many revolutions as the screw shaft. It is desirable so to attach the contact disk to the shaft that the contact with the spring, *F*, occurs exactly at the instant when one particular engine crank is passing the dead center. The tracing pens which mark the positions of the cranks may be adjusted slightly in the vertical direction, exactly in the manner described for the pens for registering the vibration curves and second-curves, so that they always lie exactly at right angles to the recording strip.

In the analysis of the vibration curves it is necessary to know which particular point of any one of them exactly corresponds with the instant at which one of the engine cranks has just passed the dead center, or in other words, which point of the curve the pen, *f*, in Fig. 17 is tracing when the pen, *i*, makes a mark. The pen, *i*, is then always ahead of the pen, *f*, by an amount equal to the length of the arc, a_1—b_1.

Fig. 18 may be taken as representing a portion of a diagram. If from the mark, b_1, which corresponds with the instant at which the crank of the engine goes through the dead point, a distance equal to the arc, a_1—b_1, be set off backward and the line, *m n*, be drawn, the points of intersection of the lines with the curves of the vertical and horizontal vibrations give, during the continuance of the vibratory motion, the exact position of the swing of the part of the vessel at which the pallograph is installed.

It is, then, in each case necessary first to determine the exact length of the arc, a_1—b_1, before an analysis of the diagram can be entered upon. The simplest way of doing this is slightly to move the tracing pens, *f* and *i*, while the recording strip is at rest, and then to allow the latter to run on till the distance, a_1—b_1, is free, so that it can be directly measured.

For the analysis of the diagrams it is necessary that the distance, a_1—b_1, be set off for each position of the engines for which a mark has been made. This may best be done by means of a set square, which, like the one illustrated in Fig. 19, is provided with a metal bow, *A*, *B*, *C*, *D*. This is bent down at the points, *m* and *n*, in such a manner that the piece of it, *m n*, touches the surface of the drawing board, while the piece between *m* and *c* lies on the T-square. At *A* and *D* the bow is provided with slots in which the screws there arranged take hold. In this manner it is possible to adjust the distance, *a*—*b*, exactly to the length of the circular arc above referred to. If the recording strip be made fast in a position parallel to the T-square, and the square be moved so that its edge is on the mark for the engine crank, the line then drawn along the edge of the square at the point, *a*, gives the points of intersection with the vibration curves, which correspond with the vibratory motions at the instant at which the crank in question goes through the dead point.



THE SCHLICK PALLOGRAPH.

THE "DEY" TIME REGISTER.

By EMILE GUARINI.

ONE of the most interesting time registering machines manufactured in England is assuredly the "Dey" time register, made by Messrs. Howard Brothers, Liverpool. This machine, in its newest form, takes a sheet and registers in bold type the exact time of the men's "ingoings" and "outgoings," which at the end of the week are all ready for totaling and extending in £ *s. d.* columns, showing the net amount of pay.

The mechanism is very simple. You have simply to push the pointer into the hole opposite the employe's number, and the operation prints the time and rings a bell to denote that the person's time has been properly registered. This can, it is said, be done so quickly that 1,600 men can, on eleven machines, register their time in four minutes. Moreover, the recording sheet can be examined at any moment through the plate-glass doors on either side of the machine, and the presence or absence of any employe can therefore be ascertained at a glance. The clocks in this machine are constructed with barrel and fusee to equalize the force of the main spring. The main springs are very heavy, so as to give a powerful drive, and the escapement has been specially designed in conjunction with a long pendulum and a heavy pendulum bob.

Messrs. Howard have lately effected such improvements in this machine that they now produce on the time register a facsimile of any works' time and wages sheets by combining the two. The machine takes the sheet and registers as stated previously.

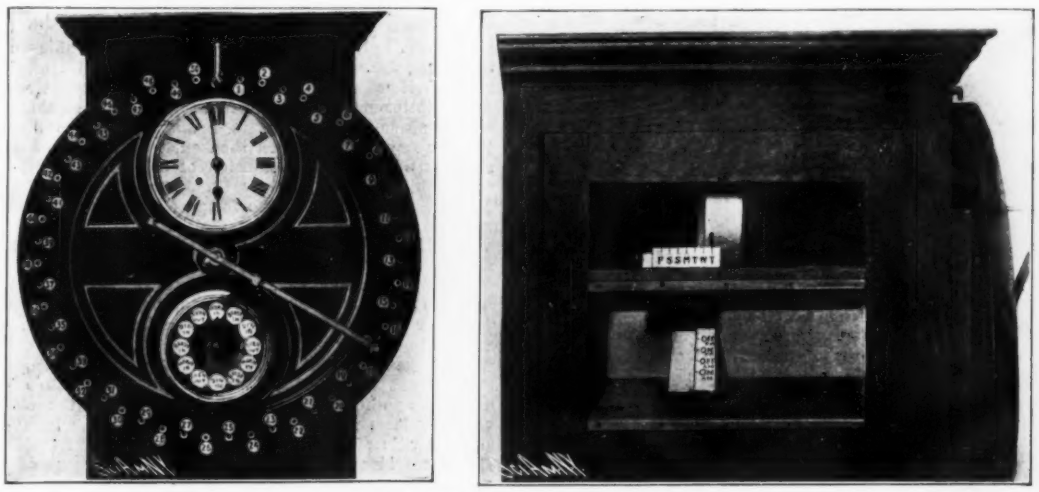
The great advantage of having a time and wages sheet combined is the circumstance that it enables firms to dispense altogether with the various time books and wages books generally employed, and another feature is that the pay clerk pays from the original sheet, and therefore can at once settle any questions that may be raised by the men, simply by referring to the sheet, the record upon which cannot be disputed since each man registers his own time.

SUBMARINES.—III.

By SIR WILLIAM H. WHITE, K.C.B.

FRENCH official documents distinguish between "submarines" and "submersibles," but there is no real difference of principle in the respective designs. Both classes are capable of entire submergence and underwater propulsion. The distinction between them consists in the larger reserve of buoyancy and higher freeboard of the submersible type when floating at minimum draft. As a consequence, the submersible type enjoys better conditions of propulsion and habitability when on the surface; while the amount of water which has to be admitted into tanks before submersibles are ready for diving is necessarily greater than the corresponding admission for submarines. Many of the latter type are of relatively small dimensions, but some submarines are of large size, and have been furnished with light forecastles and flying bridges for the purpose of securing better accommodation for their crews and assisting propulsion at the surface. It was anticipated, and, indeed, it seemed probable, that the submarine type would gain upon the submersible in the time required to pass from the surface condition to the diving condition; and it was held that such a gain in rapidity of diving might be of great value on service. Trials made recently with representative vessels of the two types have, however, led to the conclusion that the submarine type does not gain sensibly, if at all, upon the submersible in this particular; whereas the submersible has been proved to be much superior in regard to surface-propulsion, maneuvering-power, and habitability. Two vessels were tried at Cherbourg in March last before a special commission, presided over by Admiral Philibert—the "Aigrette" (submersible type), and submarine "Z." The "Aigrette" is a vessel about 118 feet long and of 170 tons displacement, with engines of 200 horse-power, and an estimated surface speed of about 10½ knots. Submarine "Z" is about 136 feet in length, of 200 tons displacement, with engines of 190 horse-power intended to secure a surface speed of 11 knots. A small forecastle was built at the forward end of "Z" to house the torpedoes and to assist propulsion, while a light flying bridge was added in order that the crew might obtain fresh air in the surface condition. Detailed reports of the trials have appeared in Le Yacht, and elsewhere; from which the "Aigrette" appears to have been superior to her competitor in maneuvering power, in steadiness, and in speed, much more comfortable for the crew, and more rapid in preparation for diving. The superiority in behavior of the "Aigrette" is said to have increased as the wind and sea rose. As the result of these trials it is anticipated that the submarine type will give place to the submersible type except for coast or harbor defense, wherein a small radius of action suffices. For offensive work, requiring a larger radius of action, the submersible type is considered necessary. French writers are of opinion that large submersible vessels might be employed in attacks on an enemy's coasts, both in the Northern Seas and in the Mediterranean; vessels of about 400 tons and 600 horse-power, attaining a surface speed of 12 knots, are regarded as satisfactorily fulfilling the requirements. Further, it is held that for harbor and coast defense, vessels of about 100 tons displacement should suffice. Besides these two types some authorities recommend the construction of a third type of small submarines which could be lifted on board and carried by ships, much as second-class torpedo boats and vedette boats are carried in battleships and cruisers. Special lifting appliances must be provided, so that the submarines might be put afloat quickly in a condition ready for immediate service. The French have already dispatched some of their smaller submarines (about 77 feet in length, and 68 tons displacement) to Saigon in order that they might form part of the *défense mobile*, and no difficulty was experienced in their transport. A small experimental submarine specially adapted for the service indicated is said to have been ordered in 1904, the length being about 36 feet and the displacement 21 tons. The Goubet type of submarine was of very small size and was worked out successfully by its inventor; but it has not been officially approved or adopted by French naval authorities. It could have been readily carried on shipboard, being about 20 feet long with a lifting weight of less than 10 tons; the speed was about 5½ knots, and the radius of action 25 knots. Propulsion was by electrical power, and the armament consisted of locomotive torpedoes carried outside the vessel with suitable releasing gear.

The trials of the "Aigrette" and submarine "Z" are said to have led to the suspension of the construction of proposed submarines of 420 tons displacement ("Emeraude" class), and of smaller submarines which M. Pelletan had ordered in amendment of his predecessor's programme for vessels of the "Aigrette" class. So far as these trials in France bear upon British construction, there is every reason for congratulation. Our later vessels have all been of the submersible rather than of the submarine type; and their designs have been continuously improved on definite lines toward one general direction. Our B class of submarines are of 300 tons displacement and 850 horse-power, with a surface speed of 13 knots, and radius of 500 miles. Fresh supplies of gasoline can be readily obtained at sea from depot ships. These vessels, therefore, compare favorably with the future submersibles contemplated in France. As to the time required for diving, the British submarines take three minutes, which is less than the time occupied in the French trials. Obviously, it is a serious hindrance to real progress if the personal views of any individual who may temporarily occupy the post of Minister of Marine are allowed to interfere with well-considered programmes of naval construction. In France this has happened repeatedly, and every one familiar with French naval literature knows how strong has been the expression of opinion by competent writers in regard to the evil of continual changes of policy. The debates on current



THE "DEY" TIME REGISTER.

French Navy Estimates since M. Thomson has become Minister of Marine have illustrated and condemned afresh the proceedings of amateurs in naval design, whose political position enabled them to suspend or to radically change schemes which were in process of execution. Fortunately we have not suffered in a similar way as yet, and it may be hoped we never shall.

The French *defenses mobiles* at naval ports associate torpedo-boats and destroyers with submarines, small armor-clads being used as supports. Statements made by the Financial Secretary to the Admiralty in March last (during the debate on the Navy Estimates) indicate that the Admiralty policy is in general agreement with French practice so far as the association of submarines and surface torpedo-vessels is concerned; but there was no mention of armored vessels being employed as supports. In speaking of submarines Mr. Prettyman said:

"They are able through their invisibility to do in the day exactly what surface torpedo craft can do by night. The main attribute of the latter is invisibility; that invisibility submarines attain by day. They have, of course, a very considerable moral effect upon an enemy. . . . You may classify a submarine as a 'daylight' torpedo boat of moderate speed and very considerable radius of action. . . . It is not a present condition, but it certainly may be looked upon as a possible condition, that certain areas in war time, by the use of surface torpedo craft by night and submarines by day, may be practically denied to large ships. At present the only answer to them is that the other belligerent should be in a similar position to deny these same waters to its enemy's ships. Therefore the submarine in that particular is the only answer to the submarine. There is one other immediate and very important function of the submarine, and that is the defense of our ports, harbors, and coast. That is the most important point. It is quite clear that the use of the submarine expands the range of the defense far beyond the guns of the forts defending any harbor. These vessels will not only defend the ports but link up the defenses, and the possession of a sufficient number of them would greatly reduce the anxiety of any admiral intrusted with the defense of our coast."

This official statement of the *rôle* to be assigned in the immediate future to British submarines obviously had been carefully considered, and action has since been taken in assigning to each of our great naval ports a group of submaries and a depôt ship which can "mother" the group. Further, it has been decided that the system of submarine (observation) mines hitherto adopted as an important section in schemes of harbor defense shall be abolished, torpedo vessels and submarines being employed instead. Mr. Balfour, in his recent explanation of work done by the Committee of Imperial Defense, stated that "the submarine mine is, at all events as far as this country is concerned, a very inexpedient method of attempting to secure the safety of these ports. It is a method more likely to produce an injury to the defenders of the ports, or to the commercial interests concerned, than to the enemy; and other methods should be substituted for this method, which, in our opinion, is not only antiquated, but dangerous." Many authorities take exception to this view and dispute the wisdom of abolishing existing arrangements; but the change decided upon is in process of execution at the great naval ports and the defensive flotillas are being organized.

Coast and harbor defense has been treated hitherto as the special function of existing submarines; but the development of the type and the large increase which has been made in size, engine power, speed, and radius of action indicate the possibility of British submarines, as well as surface torpedo craft, being employed in future operations against an enemy's coast where the defense includes flotillas of a similar character. As the result of numerous experimental trials with vessels of their *défenses mobiles*, French writers agree that close blockade of harbors and coast-lines has been rendered practically impossible by the introduction of swift surface torpedo-boats and the use of submarines. The operations off Port Arthur have furnished striking illustrations of what is likely to happen in future blockades. Although submarines were not employed by the Russians, the Japanese battle-fleet kept at a considerable distance and was linked up by cruisers to inshore squadrons of torpedo vessels. If submarines had been present, similar dispositions would doubtless have been maintained. If the Russians had used submarines and the Japanese had possessed vessels of that class, there is no probability that rival submarines would have been used against each other. A defending force operating from a well-equipped base over a moderate radius will always possess great advantages over an attacking force of submarines and torpedo craft attached to a blockading fleet. For purely defensive work submarines of small size will be capable of fulfilling the restricted conditions of service. A larger number of such vessels could be constructed for a given sum and the chances of a successful attack would undoubtedly be increased by increase in numbers. This is the explanation of the latest French proposals for two types, the larger designed for offensive operations, and endowed with a considerable radius of action, and the smaller limited to defense. No doubt the larger type could perform the duties which it is proposed to assign to the smaller, but for a given total expenditure more vessels can be obtained when both types are built; and, assuming the limited radius of action and lower speed to be reasonable for coast and harbor defense, the destructive power of the smaller type, when a successful attack has been made and the enemy has been attained by the locomotive torpedo, is practically the same as that of the larger type. There is no indication that a similar policy finds favor at the Admiralty, but it may be presumed that our earlier and smaller submarines will be utilized for coast defense only; and, as improved types are introduced, vessels which preceded them will fall back into coast defense duties. Submarines, like all other types, must suffer degradation in relative rank by lapse of time and improvements in construction.

The submarines which the Japanese navy are understood to have acquired since the war with Russia began are said to be of dimensions approximating to the Holland type, adopted for the United States navy, and repeated in the first orders given for the Royal navy. It seems improbable that use was made of these vessels in the great battle in the Korean Straits, and no Japanese report up to the time of writing makes reference to submarines; so that Russian reports of their employment and success are probably erroneous. The heavy seas which prevailed in the earlier stages of the battle were most unfavorable to the use of submarines of the type described, and the continuous movements of the fleets while engaged involved small prospect of successful submarine attacks. On this point, however, fuller information will be available hereafter, and it will be of great interest to see what the policy of the Japanese authorities will be in the immediate future.

THE SCIENTIFIC INCONGRUITIES AND ANACHRONISMS OF ARTISTS.*

By T. C. HEPWORTH.

IT is the province of the painter, as it is no less of the actor, "to hold the mirror up to nature"; and if the reflection which it gives us is not a true one we have cause for complaint. At the same time, we do not want the reflection to be too true; we look for some amount of idealization, and should be sorry if the artist were to produce pictures which were photographic in their map-like accuracy. He must confer upon his work some of his own individuality, while at the same time he exercises his discretion in suppressing certain parts of the scene before him, and bringing other parts into that prominence which his trained eye tells him is necessary to secure the scheme which he has elaborated in his mind. In other words, he is able to imbue his work with that artistic merit which is lacking in a mere photograph.

But although the wielder of the brush has this license and latitude, he must ever be careful not to outrage truth by any glaring inconsistency, and he is extremely likely to do so unless he is a man of wide general knowledge, or makes a point of knowing all that is to be learned about the particular subject which he undertakes to portray. To give a comparatively recent instance of an error of the kind we mean, we call to mind an exhibited picture in which was represented a tiger slaking its thirst at a stream. The artist did not show much more than the head of the beast, and it was life-size; but he made the terrible blunder of burying the mouth of the creature far below the surface of the water, making it drink as one may see a horse any day drinking at a trough, and not lapping up the liquid like a cat, as of course a tiger would. It is difficult to understand how an artist who could paint well enough to command for his picture a place on the walls of an important exhibition could make such a fundamental mistake. Another example we remember, also exhibited, in which a dove with outstretched wings was the principal feature. A student of animal mechanism looking at that picture remarked that it was very pretty and poetical in idea, but by no possibility would a bird thus constructed be able to fly.

Mistakes of this kind were common enough in past times, when there were no zoological collections for study, and when artists had to depend upon travelers' tales for their information regarding foreign animals. We need not go back a hundred years to find examples in books of animals which bear very little resemblance to nature, for until the time of Cuvier these pictorial monstrosities were the rule and not the exception. At the latter end of the eighteenth century, when there was a spasmodic attempt to introduce pictures into the few newspapers which then existed, we find occasionally a rough representation of some natural history subject. Thus, in the St. James Chronicle for 1765 there is shown, in the form of a copperplate impression, a "strange wild beast" seen in France, which was said to have devoured more than seventy persons and to have spread desolation over a wide area. It was represented as having a mouth like a crocodile and the elongated body of a turnspit terrier. It was probably a hyæna which had escaped from the care of some itinerant showman.

Some years ago one of our leading men of science pointed out that painters were liable to fall into errors of another kind through ignorance of the elementary laws relating to optical phenomena, and under the title of "Physical Science for Artists" he published a series of articles full of valuable lessons and warning hints. He remarked that, although geometry had been applied to perspective and anatomy to form, artists as a class seemed to have come to the conclusion that the phenomena associated with air, sky, and sea need not engage their serious attention. And to prove his point he instanced the case of a capable painter who pictured a rainbow inside out! When the work was returned to the artist for correction, he was so much disgusted with what he regarded as a preposterous demand that he charged twenty pounds for replacing the colors of the bow in their proper relative positions. Another painter had the temerity to place a crescent moon in the eastern sky directly opposite to a setting sun. When the fault was demonstrated to him he defended his action on the score that if he had painted the moon full, as it certainly would have been in nature under such conditions, it would have upset "the balance of the picture."

This gentleman was by no means the only artist who has fallen into a mistake with regard to the earth's satellite. Examples might be quoted in which the new moon had its convexity turned away from the sun, which is, of course, an impossible state of things, as any one may test for himself by experimenting with an orange and a lighted candle. Sometimes, too, the moon has been represented close to the constellation known as the Great Bear, a part of the heavens which it has never been known to invade. Then the size of both the moon and the sun as represented in paintings has often given rise to protests from those whose words are worthy of heed. An American astronomer once took the trouble to measure in several paintings the size of the moon, and to deduce from it the height of the mountains shown in the same pictures. He found that the average height of the hills was about forty-three miles, while one giant peak raised its head more than one hundred miles above sea-level!

It would be absurd to tie an artist's hand, and to say that every touch of his brush must be made with scientific accuracy. The imaginative faculties must have play, or we should have no pictures worthy of the name. Turner, who was one of the greatest masters of landscape composition and coloring, frequently exaggerates the heights of his hills with the intention of conferring upon them a majesty which otherwise they would not possess. Two of his pictures we have in mind in which this exaggeration is patent to those who know the places represented. They are the views of Hastings and Dover from the sea, made familiar by well-known engravings from the original pictures. The hills are quite double the height that they are in reality.

If mistakes are possible to artists in these advanced times, when every branch of knowledge is specialized and pursued with such enthusiasm, and when it is so easy to obtain encyclopedical information, it is not surprising that errors of a far grosser kind were committed by the painters of past centuries, whose learning was necessarily limited by their environment. "For if they do these things in a green tree, what shall be done in the dry?" The most common errors were those brought about by confusion of period, by which the affairs of centuries apart were dovetailed and blended in the most curious fashion. If we refer to the early works of German, Flemish, and Dutch artists we shall find both anachronisms and incongruities in plenty. That the Garden of Eden should be painted by a Dutch artist as having well-clipped borders, and yew-trees cut into quaint devices is excusable, for the draughtsman was quite unacquainted with any other type of garden. In D'Israeli's "Curiosities of Literature" (edition 1794) we find reference to a picture, which at that time was to be seen in a Dutch village, in which "Abraham appears ready to sacrifice his son Isaac by a loaded blunderbuss." This would antedate the use of firearms by more than three thousand years. But this is by no means a unique instance of the too early introduction of firearms by aspiring artists. Pictures are known of the Israelites crossing the Red Sea armed with muskets and other weapons of offense of comparatively modern date. Quite recently there was sold in London a beautiful Augsburg early seventeenth century ivory tankard carved with the story of the good Samaritan, one of whose servants was carrying on his shoulder a formidable gun! In some of these pictures, in which we must give the artist credit for all sincerity of purpose, simplicity of idea comes into play, as, for instance, in more than one treatment of the parable of the mote and the beam. It is difficult to say, perhaps, what the nature of the beam was that was overlooked by its possessor when he essayed to remove the mote from the eye of his companion: possibly a beam of light, which would have the effect of dazzling and impeding the vision. It was certainly not a beam of wood rectangular in section and several feet in length, as represented in some of these early pictures. Such an artistic interpretation of the story may be found in a series of wood cuts illustrating the New Testament by one Solomon Bernard, published at Lyons in 1553.

It is in the matter of costume that the early painters found such a stumbling-block, and there is no difficulty in seeing how this arose. They painted the scenery and the dresses of such widely different countries as Palestine and Egypt without having any knowledge concerning these places or any opportunity of acquiring reliable information. It was as if an artist who had never been out of the city of London, and was wholly dependent for his knowledge of things upon what he saw around him, was commissioned to draw a picture of Julius Cæsar. Would it be astonishing if he gave that noble Roman a frock-coat and a top-hat? This certainly would not be more incongruous than the well-known example in the Edinburgh National Gallery, a picture in which Pharaoh's daughter and her ladies are arrayed in the long-waisted bodices and hooped skirts common to Europe in the sixteenth century. In another picture of the same date representing "Joseph and his Kindred in Egypt," which is hung in the National Collection, London, there is no trace of the distinctive features of Egyptian architecture about the buildings; they are all Italian in type. Note, again, another picture by Paolo Veronese in the same gallery, "The Family of Darius

* Chambers's Journal.

at the feet of Alexander after the Battle of Issus." Again we have these pointed waists and enormously distended skirts, which are certainly incompatible with an event which occurred in the year 333 B. C. The artist was a Venetian, and he drew the Venetian costumes of his own period, 1528-88. In many pictures depicting events closely associated with the foundation of Christianity we find figures introduced clothed in armor. This would not be of itself an anachronism, for we are told that Goliath in his combat with David was armed with "a coat of mail," which probably consisted of plates of brass attached to leather. But in the pictures referred to the armor is often the beautifully damascened suit of steel which did not come into vogue until the fifteenth century. We might also take exception to the figures of monks which are often introduced into the same pictures, for the monastic system was unknown in Rome itself until about the fourth century. The artists painted from what they saw around them, regardless of time and place, and they had no opportunities of taking any other course, and we may take it as certain that when in doubt upon any particular point they would seek advice from the dignitaries of the Church for whom so much of their work was done. Raphael, like so many others, drew his Madonnas, his saints, and his martyrs from Italian models, and clothed them in contemporary Italian costume, giving the figures as a background the scenery with which he was so familiar. It was only when travelers came to visit the Holy Land and saw the people there, unchanged in sentiment, habit, and customs for centuries, that a few came to realize that the pictures were wrong.

And there was no other way, so far as that country was concerned, of getting at the true facts except by travel. For the Jews, in their hatred of everything in the shape of a graven image, had preserved no pictorial records of the past. The artist was thrown back upon his imagination, aided by visual impressions of his own surroundings, and his pictures were untrue to fact. Persons and things were treated in a conventional manner, and the stereotyped forms were repeated again and again as a recognized and accepted practice. It was not until facilities were provided for visiting the East and the cradle of Christianity that any one could say with authority that the conventional forms were wrong. It was impossible for even such a genius as Leonardo da Vinci to know that a table, a spotless tablecloth, plates, knives, and forks, and saltcellars were wrongly introduced into one of his most famous works, and that the Eastern people whom he painted used neither tables nor chairs, but squatted round and ate from one dish.

To come to more recent times, we shall find that anachronisms of costume and scenery were as common little more than a century ago in dramatic representations as they were in pictures. We have in our possession some old copperplate engravings which give certain evidence of this. We need only refer to one here, which has for its title "Mrs. Hartley in the Character of Cleopatra." She is dressed in a hooped petticoat, over which is a pannier skirt and a long train, the skirt being adorned with festoons of roses. Her waist is confined in the stiffest of corsets, while she wears on her head an earl's coronet surmounted by an ostrich plume. It would require the pencil of a Leech or a Phil May adequately to express Antony's surprise when he saw his Cleopatra arrayed in such fantastic style.

And it would not be the first time that a picture had been caricatured by reason of some incongruous feature. For instance, there is a well-known picture of Napoleon crossing the Alps. This subject has been quite a favorite theme with artists; but the particular example referred to shows the Emperor in gorgeous uniform mounted upon a richly caparisoned steed, which is prancing with delight at the august burden which it is honored by carrying. Such is the romantic idea of the event as it was presented to the mind of the imaginative painter. The caricaturist has given us a far more prosaic representation of Napoleon's famous journey. It is snowing hard, and the Emperor, so closely wrapped in his cloak as to look like a mere bundle of rags, is crouched up on the back of a wretched mule. A tall chasseur, as lean as the poor mule, grasps the animal by the tail with one hand and flogs it with the other. The caricature is probably far more historically correct than the more serious work.

Happily, it is getting more difficult every day for an artist to fall into error, for a much slighter fault than any of those cited is at once detected, and the detector is generally so proud of his acumen in noticing the slip that he at once gives it "bold advertisement." It is good for art generally that this should be the case, just as it is profitable for us all to have our faults pointed out to us.

THE EMISSION OF N-RAYS BY ODOROUS SUBSTANCES AND THE ACTION OF N-RAYS ON THE OLFACTORY AND OTHER SENSES.*

THE N-rays exercise a definite action on olfactive sensitiveness. This becomes apparent by bringing near the nose during olfaction any object capable of supplying these rays, such as a piece of tempered steel or of compressed wood, or the fist. The test should be made with the precautions requisite in such cases, in still air, very slowly, and with gentle and regular respiration, the odorous body being kept at a fixed distance, and more or less near the limit of sensitiveness, according to the case. The source of the N-rays may either excite sensation when the limit is nearly reached or may intensify the sensation when this has been produced. In either case the action is appreciable. It takes place when the radiating source is brought near the olfactory nerves or the base of the nostrils. If the muscular mass of the thumb is held against the *ala* of the nose, the slightest contraction of these muscles produces the effect indicated. A bar of steel held in wooden pincers is a convenient and effective source. The oil of cassia is a good substance for study. I have obtained the same results with various odors, the essential oils of lavender, thyme, and cloves, mint, camphor, ether, iodoform, ammonia, and acetic acid. The action traverses aluminium, and it is well, in order to avoid the currents of air due to the displacements of the source, to put a large plate of this metal against the front part of the nose, while operating on the other side of the plate. The N-rays may also influence olfaction when they are made to act on certain points of the nervous centers, as when the source is brought near the middle of the forehead, immediately above the *glabella*, the place of junction of the arches of the eyebrows, and especially when it is placed on the top of the cranium, a little in front of the *bregma*, the place of junction of the frontal and the two parietal bones. In the latter case the effect is striking. This effect of the N-rays does not bear exclusively on the perceptive organ. The olfactive sensation is augmented to a certain degree when the radiating source is brought near the flask containing the odorous substance, at a distance from the nose great enough not to influence it directly. On the other hand I have noticed that the preceding substances emitted the N-rays distinctly, that the rays pass through corks and aluminium plates, but are arrested by lead, and may give rise, like those of the other sources, to conduced radiations.

Respecting the action which the N-rays may exercise on the other senses, I have noticed a distinct influence in the sensation of taste. If a particle of a sapid substance, as camphor, aloes, salt, or sugar, is deposited on the point of the tongue, with the mouth open, the respiration suspended, and the palate raised to prevent all olfactive effect, the approach of such a source as a bar of tempered steel produces or increases the sensation of taste. The sensation is still further intensified by the N-rays, when, instead of localizing the sapid body on the point of the tongue, it is diffused through the mouth. There are points of the cranium on which the action of the rays may augment the gustatory sensation. After tests on different parts of the cranium, I have discovered this action of the rays only in a parietal zone near, perhaps a little anterior to, that in which there is action on the sense of sight.

The study of the sense of hearing is more difficult, on account of the precautions to take for preventing the displacements of the radiating source with reference to the ear from modifying by variable reflections the access of sound. Success is attained, however, by utilizing conduced radiations. On taking as a sonorous source a watch held at the limit of the perceptive distance, I have noticed distinctly an intensification of the sound only when the terminal plate was placed directly above the ear, seven or eight centimeters above the auditive orifice, which appears to accord with the idea of an excitation bearing on the cerebral centers of audition.

* From the French of M. Augustin Charpentier.

THE TEMPERATURE OF FLAMES.*

IF a flame contains a solid substance of known radiating power we can determine its temperature without putting an instrument into it. A luminous flame contains carbon in the solid state, and it is possible in such a case to measure the temperature of one part of the flame at least by means of instruments placed at a distance from the flame; but for what are commonly called non-luminous flames, such as the flame of the Bunsen burner, which contains no solid particles, it is necessary to introduce the temperature measuring instrument into the flame itself. It now becomes desirable to consider more closely what it is exactly that we mean when we speak of the temperature of a flame, and we must direct our attention for a moment to the shape and structure of flames.

If a gas is mixed with the amount of air necessary for its complete combustion before it issues from the burner, we shall have a flame of the type in which the burning process is going on through and through to the central cone of unburned gases. If, however, we burn gas in the more usual way, by allowing it to flow out into the atmosphere without previous mixture with air, or after admixture with only a portion of the air that it requires, we shall have a flame of a different character. In the first case, that is, where no air at all has previously been mixed with the gas, the flame will consist of a shell of combustion of no considerable thickness. In the second case, the flame will consist of two shells of combustion, one an inner cone in which combustion occurs so far as the amount of air admitted with the gas will reach; the second shell, an outer cone of combustion where the half-burned gas is burned fully in the outside air.

The professor proceeded to illustrate by an experiment how in the case of a flame of benzene vapor the structure of the flame is altered in accordance with the amount of air supplied to the vapor before it issues from the burner.

* Lecture by Prof. Arthur Smithells, B.Sc., F.R.S., before the Institution of Gas Engineers.

MEANING OF FLAME TEMPERATURE.

Now, what are we to understand when we speak of the temperatures of these different flames? If we speak of the temperature of a current of warm air, we usually think of a uniform condition prevailing throughout the stream, and we should measure the temperature and understand it in the same way as if we were measuring the temperature of a stream of water. But as a flame consists usually of thin shells of combustion, it is obvious that the distribution of temperature throughout the whole volume of the flame must be very different from that in a current of uniformly heated air. In the middle of a flame we may have a temperature not very greatly above that of the surrounding air; at the edges of the flame, a quarter of an inch away, we may have a temperature above the melting point of platinum. Again, if we consider a flame from bottom to top we have no reason to expect that the temperature will be uniform. To thrust any instrument like an ordinary glass thermometer into a flame would, obviously, be absurd, for only a very small fraction of the bulb might be in the hottest part of the flame, and the temperature we should measure would give us no sort of idea of the thermal effects we could really obtain, say, on a Welsbach mantle. The temperature of a flame, as a matter of fact, is usually taken to mean either the temperature of the burning parts, or, if no further qualification is made, it means the highest temperature which can be found anywhere in the flame; but, as I have before insisted, it is extremely important that when the expression "the temperature of a flame" is used there should be an exact specification of what is meant, a clear indication of what part of the flame is referred to, and a description of the method by which the measurement has been made.

Having regard, then, to the structure of flames and to the great variations of temperature that occur within very small distances, it would seem desirable to have a measuring instrument of the smallest possible dimensions. The smallest instrument we can make will be gross compared with molecular dimensions. When we recollect that a hundred thousand million molecules of hydrogen heaped together would form a speck hardly visible under our most powerful microscope, we shall realize that our smallest instrument will still give us an indication only of the average condition of a vast multitude of molecules.

CALORIFIC VALUE AND TEMPERATURE.

If we are asked what is the relation between the calorific value of a gas and the temperature of a flame which it will produce, we may reply that though in general the higher the calorific value the higher the temperature of the flame which it can be made to give, this is not necessarily always the case. If we have two specimens of gas of the same calorific value, but of very different chemical composition, we may have considerable differences in the amount of air which they require for complete combustion; and so, although the rates of supply of the gases may be the same, and the rate of oxidation be the same, the different amounts of atmospheric nitrogen brought into the flame will produce differences of volume of the flame and consequently differences in the temperatures of their external surfaces.

CONCLUSION.

In conclusion, I draw your attention to a table in which I have collected the various estimates that have been made of the highest temperature of a Bunsen flame of coal gas. Of course, the gas used has not been the same in the different cases, but the discrepancies are far beyond anything that could be accounted for by that fact. The cause is to be found in the various sources of error to which I have already alluded. I also may direct your attention to a table of maximum temperatures which has recently been given by Prof. Féry as the result of an ingenious, though, I venture to think, not entirely unexceptionable, method of measurement, based upon the reversal of the D line of sodium vapor in a flame when viewed against an electric filament of known and alterable temperature. These figures will give you an idea of the intensity of heat obtainable with gaseous fuel. I may add that M. Féry estimates the temperature of the electric arc to be 3,760 deg. C., and that of the sun to be 7,800 deg. C.

Maximum Temperature in Flame of Bunsen Burner using Coal Gas.

Date.	Deg. C.
1860 Bunsen and Kirchhoff	2,350
1877 Rosetti	1,360
1892 Rogers	1,230
1892 Lewes	1,630
1895 McCrae	1,725
1896 Waggener	1,770
1899 Berkenbusch	1,830
1902 White and Traver	1,780
1905 Féry	1,871

Maximum Flame Temperatures (Féry, 1904).

	Deg. C.	Deg. F.
Bunsen burner, gas fully aerated	1,871	3,400
Bunsen burner, insufficient air	1,112	3,114
Acetylene flame	2,548	4,618
Alcohol flame	1,705	3,101
Denayrouze Bunsen, alcohol and air	1,862	3,384
Denayrouze Bunsen, half each alcohol and petroleum spirit	2,053	3,727
Hydrogen, free flame in air	1,900	3,452
Oxy-coal gas blow-pipe flame	2,200	3,992
Oxyhydrogen blow-pipe flame	2,420	4,388

AUTOMOBILE LAWN MOWERS.

CONSIDERING the amount of space occupied by lawns in cottage gardens and in public and private parks, it was but natural that an endeavor should be made to improve the apparatus with which they are mowed, with a view to curtailing manual labor. For the purpose of shortening and expediting the work, it is not astonishing that automobile mowers should have been invented to take the place of horse-drawn and hand-pushed apparatus; and so for several years past various types of such machines have been making their appearance, although the operation of some of them has left much to be desired.

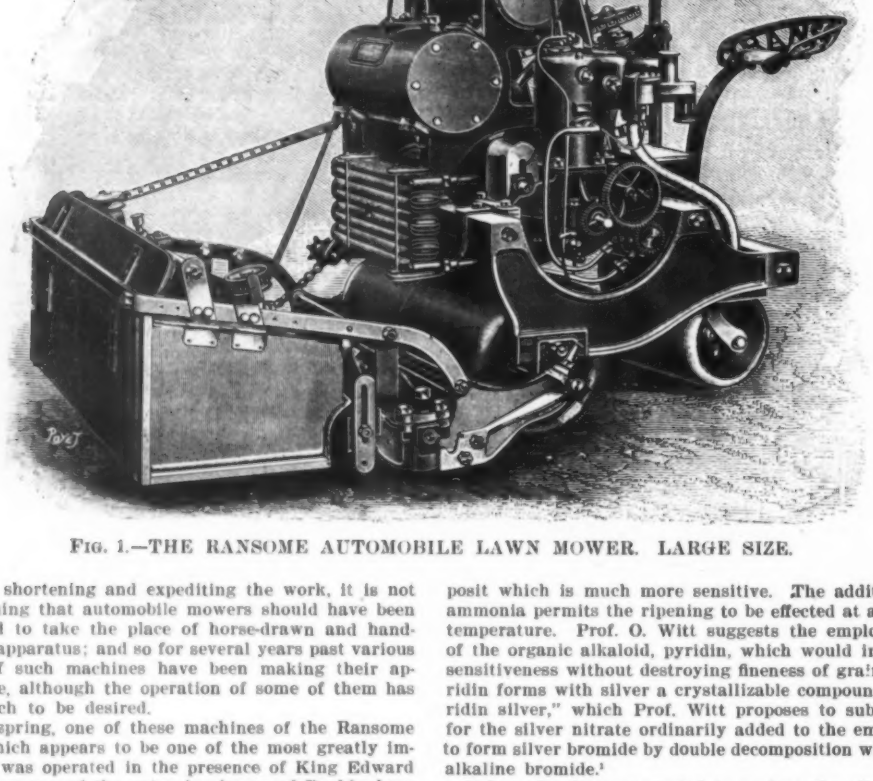


FIG. 1.—THE RANSOME AUTOMOBILE LAWN MOWER. LARGE SIZE.

This spring, one of these machines of the Ransome type, which appears to be one of the most greatly improved, was operated in the presence of King Edward VII., upon one of the extensive lawns of Buckingham Palace park, and his Majesty was so pleased and satisfied with its performance that he at once ordered one for use upon his estate.

This type of mower, which is actuated by a gasoline motor, is manufactured in several sizes, from one 24 inches in width to one of 40 inches. The essential difference resides in the fact that the large machines are provided with a seat (Fig. 1), while the smaller ones are guided by a man walking in the rear (Fig. 2). These machines comprise the same essential organs as horse-drawn mowers and the small garden ones. A screw in front throws the grass into a box ahead of it, while the roller or rollers are placed in the rear. From the seat placed over the rear roller the driver of the large type performs the same manipulations as the man who steers the smaller type from behind. In both types, the arrangement in front of the boxes for catching the grass is a very important feature, since it does away with the necessity of a laborious sweeping and gathering of the grass after the operation of mowing, with the result that the expense of hand labor is very greatly reduced.

RECENT PROGRESS IN PHOTOGRAPHY.

By DR. LUDWIG GUENTHER.

THE steady progress in photographic technique is most clearly manifested in the continual improvement of photographic plates. Of their two chief requirements, great sensitiveness and fineness of grain, the first has long been attained, but at the cost of the second, for the two have hitherto appeared to be incompatible. Yet the prevailing custom of making enlargements from very small negatives has sharpened the demand for exceedingly fine-grained plates, which are also very desirable for lantern slides.

The new Σ (sigma) plates of Lumière appear to combine fineness with sensitiveness.

The emulsion of very rapid plates is usually "ripened" by heating, the result being that the finely divided silver bromide is converted into a coarse-grained deposit which is much more sensitive. The addition of ammonia permits the ripening to be effected at a lower temperature. Prof. O. Witt suggests the employment of the organic alkaloid, pyridin, which would increase sensitiveness without destroying fineness of grain. Pyridin forms with silver a crystallizable compound, "pyridin silver," which Prof. Witt proposes to substitute for the silver nitrate ordinarily added to the emulsion to form silver bromide by double decomposition with the alkaline bromide.[1]

It has also been suggested to replace the silver nitrate by silver nitrite and to act upon this with ammonium bromide. Ammonium nitrite, the by-product of this reaction, separates into nitrogen and water at the temperature used in emulsifying, so that the tedious washing to remove the alkaline nitrate is avoided. This process also yields a fine grained and very rapid emulsion.[2]

But the amateur photographer has at his own disposal various means of producing a fine silver deposit on his plate. One of these is slow development, for the slower the development, the finer is the grain of the layer of silver. Slow development won its great triumphs several years ago. The enthusiasm for it has since greatly diminished because it entirely precludes the possibility of influencing the character of the negative.

Now, however, the Lumières, in conjunction with Seyewitz, have given us two developers, paraphenylendiamin and orthoamido-phenol, with which deposits of exceedingly fine grain can be obtained. These developers belong in the same class with rodinal, metol, and pyrocatechin. They are not new, but have hitherto been neglected because of their slight, or rather their slow, developing action.

Fine-grained deposits, however, may be obtained with ordinary developers. The addition of ammonium chloride to the developer effects a partial solution of the silver bromide, and the dissolved portion, under the reducing influence of the developer, precipitates a minute quantity of metallic silver which accumulates about the silver which has been separated during the exposure.

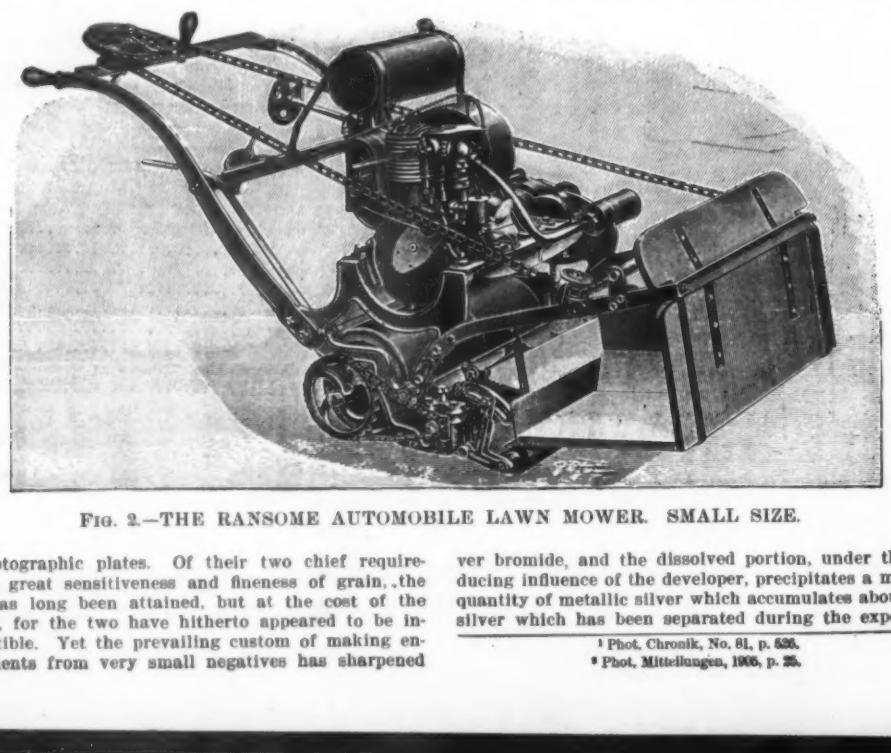


FIG. 2.—THE RANSOME AUTOMOBILE LAWN MOWER. SMALL SIZE.

[1] Phot. Chronik, No. 81, p. 526.
[2] Phot. Mitteilungen, 1905, p. 25.

Besides this action, which is analogous to that of a "physical developer" or silver intensifier on wet collodion plates, the ordinary chemical development goes on. The latter initiates the development, while the former determines the fineness of the deposit.

This brings us to a novel method of development. Neuhauss has found[3] that if an exposed plate is first fixed in darkness, the image may then be brought out by a physical, or silver, developer in daylight. To many an amateur the idea of fixing before development will seem absurd, for it contradicts one of his fundamental principles. Nevertheless, it can be done very easily, and it produces negatives of very fine grain. The plate, by the way, should be slightly overexposed.

To explain the phenomenon we shall have to take a little dip into theory. When a silver bromide gelatine plate is exposed a greater or smaller, though always immeasurably minute, quantity of bromine is set free from the normal silver bromide molecule, leaving a sub-bromide or "photo-bromide," to which the hypothetical formula Ag_2Br has been assigned. In the process of fixing this salt is decomposed into normal bromide and metallic silver ($Ag_2Br = AgBr + Ag$). The normal bromide is dissolved by the fixing solution and the free silver precipitates as a nucleus of exceedingly fine grain, which subsequently attracts to itself the "nascent" silver which is precipitated from the "physical" or silver developer. It is evident that this power of attraction and accumulation of silver is proportional to the density of the original nucleus and, therefore, to the exposure. On the other hand, the latter may vary from one to five times the normal exposure without affecting the character of the resultant negative if the development is continued for the proper time—which may, in some cases, extend to twelve hours. The degree of over-exposure affects only the rapidity of development.

Neuhauss gives the following formula for the developer: Distilled water, 100 cubic centimeters; ammonium rhodanate, 24 grammes; silver nitrate, 4 grammes; sodium sulphate, 24 grammes; hypo, 5 grammes; 10 per cent solution of potassium bromide, 6 drops. This stock solution is absolutely permanent. The actual developer is made by adding 6 cubic centimeters of the stock solution to 2 cubic centimeters of rodinal and 54 cubic centimeters of water. The amateur must not be discouraged on seeing the plate obscured by a shiny coating of finely divided silver, for this is easily washed off. The white color of the silver image also appears strange, but it is opaque, despite its whiteness. The negative may be darkened, and also considerably strengthened, by treating it successively with a 1 per cent solution of mercuric chloride (corrosive sublimate) and with ammonia, and various beautiful tones may be obtained by modifications of the process.

Turning from negatives to positive prints we find that the less sensitive development papers which contain silver chloride are increasing in popularity. The wide limits of exposure, the beautiful tones obtainable, the softness of the prints and the possibility of working by ordinary lamplight are important advantages of the pure chloride and bromo-chloride over the pure bromide emulsion papers.

Some printing-out papers, such as "celloidin" paper, can also be worked without the aid of sunlight. If such a paper is exposed under a negative to the light produced by burning 10 centimeters of magnesium ribbon, the latent image can be brought out by a diluted developer—a fact which will surprise many who would not have credited a printing-out paper with such a degree of sensitiveness.

But the greatest interest unquestionably attaches, at present, to the bichromate-gelatine papers, which give the fullest scope both to artistic feeling and to technical skill. The "oleograph" process of Rawlins[4] is one of the newest. A hard paper is floated, first on a solution of gelatine, and then, after drying, on a 2½ per cent solution of potassium bichromate. It is dried in the dark and exposed under a negative until the details of the high lights appear in faint brown outlines. Then it is washed thoroughly and laid on a glass plate, and the excess of water is wiped off with a clean towel. Oil color is then applied to the print with a roller. The deep shadows, that is, the parts corresponding to such in the original scene or a silver print, take up the color, which is rejected, more or less completely, by the other parts, where the unaffected gelatine is swollen and saturated with water. Ordinarily oil paints, rubbed up with turpentine to the thickness of cream, answer the purpose very well. If the result is not satisfactory, the color may be wiped off with a sponge wet with turpentine, and fresh pigment applied with the roller. The oleograph is said to possess a wealth of gradation of tone not attainable by any other photographic process.

In contrast to this process, which employs mineral pigments, stands Koenig's "pinatypy"[5] which, like his "pinactinomy"[6] and some three-color printing processes, makes use of dissolved organic colors or dyes.

The colors selected for use in pinatypy are said to be quite permanent. This process differs from others which employ organic colors in that the color is taken up by the different parts of the picture in inverse instead of direct, proportion to their exposure. It is a printing process like the others, however, and is based on the principle of the hectograph. A glass plate coated with gelatine sensitized with potassium bichromate

[3] Phot. Rundschau, 1905, p. 54.
[4] Phot. Chron., 1905, p. 73.
[5] Phot. Mitt, 1905, p. 65.
[6] Umschau, 1904, pp. 795, 815.

is exposed under a glass *positive* and then soaked in an aqueous solution of a "pinatypy" color for fifteen minutes, or until the deepest shadows have become strongly colored while the highest lights still remain clear. The plate is then washed thoroughly and a well-moistened sheet of "pinatypy" paper is pressed lightly upon it and allowed to remain in contact for fifteen minutes. When the paper is removed the picture, with all its details, is found to have been transferred to it. These prints are said to possess great sharpness, brilliant high lights, and delicate half-tones. An indefinite number of prints can be made from a single plate, the latter being immersed in the dye before each printing.

Prints in two or more colors can also be made by pinatypy. For the production of pictures in natural lines by the three-color method a glass positive is made from each of the three original negatives taken with the blue, green, and red ray-filters. From these positives three negative printing plates are made, as described above, and dyed yellow, red, and blue, respectively. Then the same sheet of paper is applied to the three plates in succession. As the plates remain fixed and the paper is pressed upon them, it is not difficult to secure accuracy of "register."

In connection with the production of photographs in two colors it may be added that pigment papers are made for this purpose by the firm of Hesekiel, which offers the combinations of jet black and brown black, dark and light brown, dark and light blue, light brown and green, green and blue, dark and light red.[7] The combinations of light brown with green, and of green with blue, are especially adapted to the production of colored landscapes, for which only a single original negative is required. From this a positive is made and, from the positive, a second and greatly under-exposed negative. The original negative is printed on green pigment film, the second negative on brown, and the brown film is transferred to the green print. The latter reproduces all the details of the original negative, but the brown picture superimposed on it shows only the trunks of trees, the soil, etc., if the second negative has been properly under-exposed. The superposition gives a polychromatic picture of very pretty effect, if the photographer possesses taste and an eye for color.[8] In the N. P. G. films (Neue Photographische Gesellschaft in Steglitz) used in this process, the layer of gelatine is carried by a thin sheet of celluloid from which, after exposure, it is easily transferred to paper.

Photographs in two colors may even be made on development paper, without the tedious detail of the pigment process.[9] A chloro-bromide paper is greatly underprinted and developed with old, often used, and very weak developer. The slow development which takes place under these circumstances, produces a yellowish-red fog which chiefly affects the lights, while the shadows appear dark brown or black. The red tint may then be removed from the highest light with Farmer's reducer (hypo and red prussiate of potash) and allowed to remain on the half-tones. The result is a print of singular beauty. The writer has observed a similar phenomenon with printing-out papers, when exposed to direct sunlight under negatives containing strong contrasts. The result is a print with deep brown shadows in the foreground while distant mountains appear covered with a bluish haze.

A combined bromide and pigment paper is made by Riebensahn and Posselt. Exposure under a negative, development, and fixing leave a silver picture imbedded in pigmented gelatine. The print is then sensitized with bichromate, washed and developed in warm water as in the ordinary pigment process. The finely divided silver has the same effect as light has in reducing the chromic acid and making the gelatine insoluble. This catalytic action of finely divided silver has often been observed. Here it is utilized in the production of a pigment paper of great sensitiveness.[10]

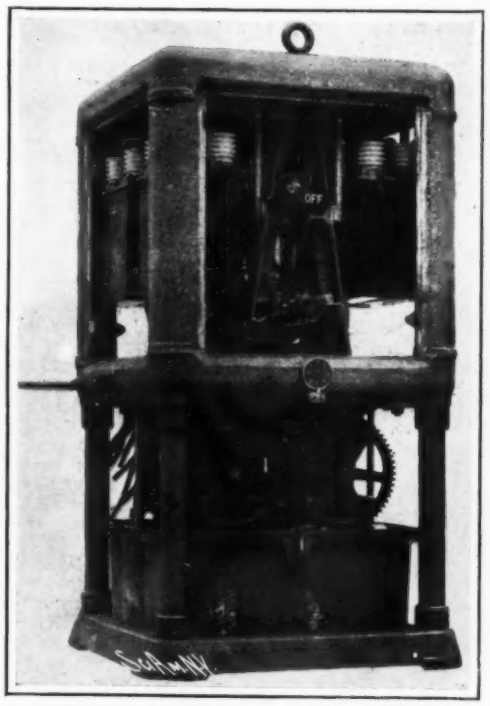
AUTO-STARTER FOR A 1,400-HORSE-POWER INDUCTION MOTOR.

AN induction motor may be started either by connecting the motor directly to the supply circuit or by applying a low voltage until the motor has attained a fair speed, and then by one or more steps to raise the potential until it reaches its normal value. The first method may be used only with motors under 5 horse-power, for when the full voltage is impressed on the motor in starting, it draws a current equal to several times full load current, which causes a heavy drop in the supply circuit and is detrimental to the regulation of the system. Further, the excessive strains thrown on the winding of the motor by starting in this manner cause deterioration in the insulation of large-sized motors.

These considerations make it necessary to provide an auto-starter, which usually consists of an oil-immersed switch or switches of the drum type used in conjunction with two auto-transformers, so connected as to apply gradually increasing voltages to the terminals of the motor. The number of points varies from three to nine, depending on the size of the motor. The advantages of a gradual development of torque manifest themselves both in the motor and in the line regulation.

The Westinghouse Electric and Manufacturing Company manufactures oil-immersed auto-starters for use with all sizes of constant speed induction motors from 5 to 2,000 horse-power of various voltages, frequencies, and two and three phase. The one shown in the illustration was constructed for the control of a 1,400-horse-power, 2,200-volt motor. The switches, circuit breakers, and operating devices only are mounted in the case, and since the auto-transformers are standard they are not shown.

This controller, known as type 197, has eight starting and one running points. At the first starting notch a



CONTROLLER WITH OIL TANK LOWERED AND COVER REMOVED.

low voltage is impressed on the motor, and as each succeeding notch is passed the voltage is increased until the full line potential is reached and the motor attains its running speed. The motor circuit is never opened in passing from one starting point to another, as preventive resistances are inserted between the different notches. Destructive arcing and wear on the contacts are thus prevented, as are also the fluctuations in the line due to starting the motor. The two auto-transformers mounted outside the case, in connection with the preventive resistances, furnish the necessary reductions in voltage for starting.

The type 197 controller is equipped with two automatic line circuit breakers and two non-automatic breakers upon which the circuit is broken when changes in voltage are made, thereby saving the current-carrying contacts of the drum switches. By the first turn of the hand wheel the circuit breakers are closed, and the motor is connected to the first point of each auto-transformer both direct and through the preventive resistances. The next step connects the motor through another set of resistances to the next higher voltage, disconnects the motor from the lower voltage and finally short-circuits the resistance on the higher voltage step. This is continued with each of the eight steps until the motor is connected to full line voltage.

The two non-automatic circuit breakers are actuated by cams connected to the shaft of the hand wheel, which is turned through 180 degrees for each notch of the controller, the change from point to point being shown on the indicator below the wheel. At any position a slight backward turn of the hand wheel will cause the main line circuit breaker to open, and the word "off" to replace the word "on" upon the shutter just above the hand wheel. An overload on the motor will also cause this breaker to open. In either case it is necessary to return the wheel to the initial starting position before the circuit breaker can be closed. The tripping coils are so connected that only a part of the turns are in circuit when starting, thus increasing the capacity for the heavy starting currents and insuring greater protection when running.

The oil tank may be lowered by the crank at the side, and the upper part of the case removed, thus exposing all parts for ready inspection and repair.

This auto-starter was designed for starting motors of from 600 to 2,000 horse-power capacity at 2,000 volts, either two or three-phase, the size of motor that can be handled depending on the conditions of service. Direct-current starting rheostats and controllers, though operating satisfactorily when used to start motors driving bucket conveyors where the machinery is started but once or twice a day, will, unless designed for heavy service, heat excessively if used to start motors of the same capacity when driving roll tables and soaking pits, where sudden and repeated starting and reversing is required. Similarly, the heating of the auto-transformers and the controller contacts depends on the frequency of starting and the starting torque required of the motor.

As this apparatus is intended only for starting, it cannot be used for varying the running speeds of the motor.

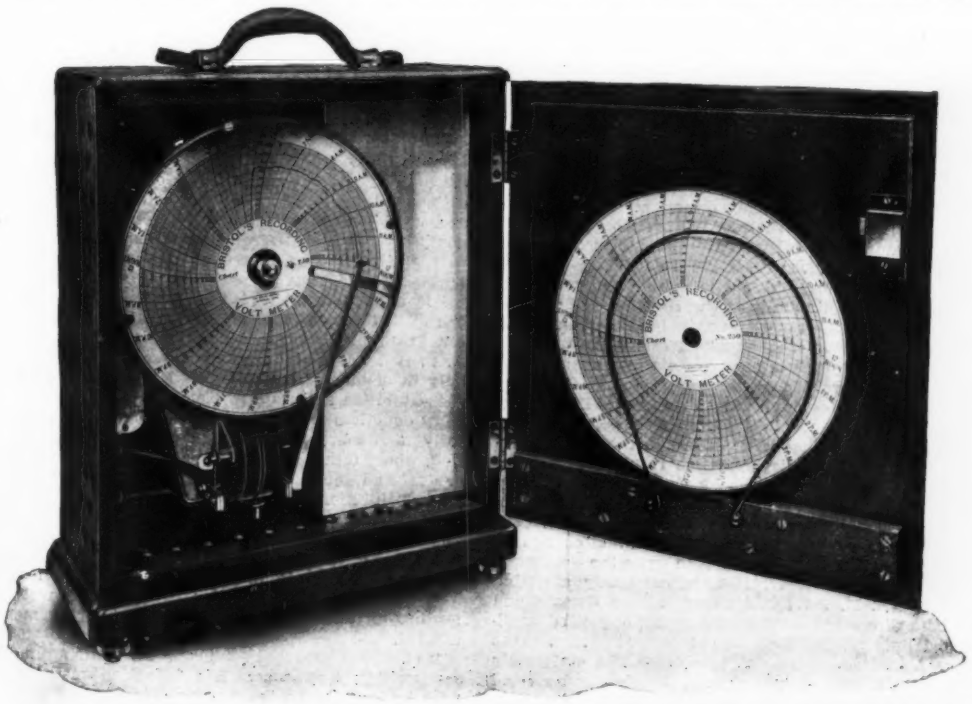
A NEW RECORDING VOLTMETER FOR BOTH DIRECT AND ALTERNATING CURRENT.

A VARIATION of comparatively a small percentage in the voltage of an incandescent lighting circuit from the standard for which the lamps are designed causes great loss in the life of the lamps and results in wide fluctuations in the efficiency and candle power. In the application of electric power, as, for instance, on an electric railway, it is of great importance that the voltage be maintained regardless of the variations in the load.

The recording voltmeter has proven itself to be of great value, and is an indispensable part of a modern electric plant, since it accurately, automatically, and continuously furnishes a written record of the slightest variation of the voltage. The recording voltmeters manufactured by the Bristol Company, of Waterbury, Conn., have been extensively adopted, but up to the present it has been necessary to furnish the instruments with entirely different current coils, according as they were to be employed upon alternating or direct current circuits.

In many electric plants both alternating and direct currents are generated, and if the same voltmeter can be used equally well for recording either kind of current, it is quite evident that a valuable advance has been made.

This has been accomplished. The accompanying illustration shows a special portable form of the instrument. The case is provided with a handle and leveling screws for convenient transportation and adjustment.



A RECORDING VOLTMETER FOR BOTH DIRECT AND ALTERNATING CURRENT.

The door is open, showing the construction and manner of operation.

The novel features and improvements to this new voltmeter are that it is equally applicable to both alternating or direct circuit; that it requires only one-third as much current to operate as that necessary for the older design for alternating currents; that it is more sensitive to very slight variations of voltage;

[7] Phot. Mitt. 1905, p. 76.
[8] Phot. Mitt. 1905, p. 56.
[9] Phot. Wochenblatt, 1905, p. 56.
[10] Phot. Mitt. 1904, p. 34.

that the chart graduations are nearly uniform on both sides of the working range; that the portable form of the instrument in its carrying case is only half the size and weight formerly required.

The solenoids shown in the illustration are connected so that when current is passing through them in series, the movable solenoid will be repelled from, instead of being attracted toward the stationary one.

The movable solenoid is mounted on a frictionless knife-edge multiplying device, which transmits its motion to the pen arm, carried by the knife-edge blade.

This simple multiplying device permits the solenoids to be located very near each other, and consequently the magnetic field of force is uniform throughout the motion of the solenoid resulting in the desirable scale divisions of the chart.

By making the construction of the solenoids so that there is repulsion instead of attraction, the mutual inductance between them is neutralized, thus making the same instrument suitable for recording either alternating or direct current. The instrument is independent of the rate of alternations and is compensated for changes of atmospheric temperature.

THE EVOLUTION OF THE TELEPHONE.

By W. H. SHARP.

IT is now something over fifty years since the telephone, as a means of transmitting spoken words electrically to a distance, was first publicly outlined in L'Illustration, Paris, August 26, 1854, by Borseul, who theoretically invented it. One month later a communication, based expressly upon Borseul's description thereof, was published under the heading "Electrische Telephonie" in the Didaskalia, Frankfort, September 28, 1854, signed "L."

Philip Reis, by whom the telephone was afterward experimentally invented, was at that time living in, or connected with, Frankfort (since 1848); and had been since 1851 a member of the Physical Society of that city. Probably he was influenced by Borseul's ideas, before he actually demonstrated the electric transmission of spoken words by means of the telephone in or before 1862.

It appears desirable, at this present time, to consider the various events connected with telephone development during the past half century, at least so far as they may enable us to trace their connection with the telephone "improvements" made by A. G. Bell in 1876. This connection has never been clearly traced, and the best attempt I know of, to settle the Reis-Bell controversy by tracing the connection from Reis to Bell, was made by Prof. Lawson Tait, in his letter published in the SCIENTIFIC AMERICAN, January 2, 1886.

That attempt failed, because that letter contained a conjecture that A. M. Bell (father of A. G. Bell) had probably been present at an exhibition at Kemp's, in Edinburgh, about the end of 1862, and might have been accompanied by his son, when the Reis telephone was shown thereat. The conjecture was erroneous, and its publication served only to bring into the discussion one who had practically nothing whatever to do with it. But that letter served to place on record the following facts in 1886:

A. That Kemp's, in Edinburgh, had a Reis telephone (transmitter and receiver) actually in use about December, 1862, as nearly as he (Prof. L. Tait) could remember the date; but certainly before 1866.

B. That Shearer (Sherer), Kemp's very "intelligent manager," exhibited that Reis telephone there, about that time, to their customers and the frequenters of that well-known "philosophical establishment."

C. That he (Prof. L. Tait), being then a student interested in physical science, was personally present on one occasion when that Reis telephone was so exhibited there, and heard spoken words transmitted and received thereby.

D. That the Reis telephone then used was, as regards its transmitter, such as is shown on page 97 of Prof. Silvanus P. Thompson's book published in 1883 on "Philip Reis, Inventor of the Telephone."

E. That the aforesaid public exhibition was much "talked of" in Edinburgh at the time.

F. That he "felt almost certain he had seen A. M. Bell there"; thought it was "extremely likely A. M. Bell would go there" to see the Reis telephone; A. M. Bell "might have been accompanied by A. G. Bell"; that he (Prof. L. Tait) recognized A. G. Bell subsequently at Plymouth in 1877; and that nothing was more likely than that it was through the chain aforesaid that the Reis telephone was transferred to America, and there became developed.

The unfortunate mention of A. M. Bell in the concluding sentence which is contained in F caused the Reis-Bell controversy to come to a sudden crisis, and change its course, for it enabled A. M. Bell to write the SCIENTIFIC AMERICAN February 27, 1886, triumphantly asserting that he (A. M. Bell) had never entered Kemp's, and that he "knew his son's work was not suggested or directed by anything Reis had done; . . . the very idea was entirely new," etc. The statements under the other headings are not therein disputed, and nothing is said as to whether A. G. Bell alone went to Kemp's, and if so, when.

That reply apparently closured Prof. L. Tait, and his clew was not followed up. If it had been followed up, the identical Reis telephone as used about 1863 at Kemp's would probably have been found reposing still upon a shelf in Kemp's workshop in 1886, or then but very recently removed from thence. Also, certain local evidence would have been available bearing thereon, which now may not be so easily obtained.

Either the "idea" of the telephone was, or was not, "entirely new," when A. G. Bell (or his agent) took out his patent for "improvements" in 1876. *If* it was, Reis did not invent the telephone fourteen years prior thereto, and the Bell telephone may have been a supernatural revelation. On the other hand, if it was not "entirely new," the Bell telephone is a result of evolution, and in any case it is open to the public, which has been made to pay an enormous price for the right to use Bell's "improvements," to inquire as to whether they were or were not "suggested or directed by anything Reis had done," or which others had done, and if so, how and to what extent.

That inquiry can surely best be made while some who may be able to give direct evidence thereon are possibly alive, and may come forward to give evidence, as, for instance, upon the matters connected with the first public exhibition of the Reis telephone in Britain *about* 1863.

I was not present thereat, but I was engaged in December, 1873, to go to Scotland, by the purchaser of Kemp's business, and I was manager of that same establishment between December, 1873, and May, 1884. During all that interval the identical Reis telephone used as aforesaid was at my disposal there. It was on a shelf in Kemp's workshop, stored with other old models, patterns, and apparatus (chiefly electrical), when I first saw it there early in January, 1874. I believe it was still in Kemp's workshop in May, 1884, when I left there. Certainly it had not been sold, nor had any one been authorized to remove it prior to my departure. What became of it after May, 1884, I have not heard. I believe the place was pulled down shortly afterward to make room for buildings of an entirely different character, and that the proprietor of Kemp's business closed it finally and sold off, by forced sale, all its plans, models, patterns, stock, scientific apparatus, etc., as he was going abroad.

Often while there I conversed with employes who had been there years before I knew the place, and who had been present at the aforesaid exhibition of the Reis telephone about 1863, and who had experimented with that telephone frequently there on their own account before and after I first went there. Also, I conversed with many scientific men who frequented Kemp's establishment, and who told me they had been present at the exhibition aforesaid about 1863. I learned there that the *exhibition* referred to was not formally so named when it took place, and was not confined to one day or stated period, but that Kemp's, having become possessed of a Reis telephone as part of their stock of electrical and teaching appliances, showed it to the people who frequented that noted scientific rendezvous, which then had a world-wide reputation. The Reis telephone lay there, I was told, and reports concerning it were spread abroad in and around Edinburgh throughout scientific circles. All who went to Kemp's, and asked to see and hear it, were made welcome so to do, and so far as time and space available permitted. Moreover, no trouble, payment, favor, or formality was involved; it was absolutely *free*. All the University and High School people interested in physical science were specially invited, and most of them attended, as also did most of those interested in physics from miles around. Eventually, it was found to take up too much time of the staff, and was stored away on a shelf in the workshop.

The results, I was told, were very erratic, so that words and sentences were transmitted with distinct articulation sometimes but often imperfectly or not at all during a demonstration, according to differences of adjustment, of support, or of other conditions which were not understood or were unavoidable at the time.

One of the Kemps had been assistant to Prof. Gregory, of the University adjoining, and one of the Kemps invented the amalgamation of zinc plates, which greatly benefited electrical science (*vide* Smee's "Electrometallurgy"). The University and High School teachers were constant customers of Kemp's for physical apparatus and materials long before that exhibition and until long after I knew Kemp's place. The students of both places frequented Kemp's in proportion to their interest in experimental physics, and as an irresistible center of attraction.

I learned there, in 1874, that the Reis telephone was exhibited there in or about 1863, that is to say, about ten years previously. About the beginning of 1863 A. G. Bell was a student, fifteen years old, and a mile only in distance from Kemp's. His teachers attended the exhibition aforesaid at Kemp's even if he did not. They doubtless told their pupils—and who would naturally take more interest than that one pupil, A. G. Bell, whose father was connected with elocution classes or deaf and dumb school teaching? Prof. L. Tait tells us the exhibition aforesaid was much talked of in Edinburgh at the time, and we have ample proof that the telephone was then being widely described in scientific books and papers.

Now I propose to arrange in chronological order some items in the main line of telephone evolution leading up to A. G. Bell's telephone "improvements" of 1876.

1837. Page produced sounds by magnetizing and demagnetizing iron rods. His induction method was used by Reis twenty-three years afterward in the telephone receiver, and afterward also by others.

Passing all that was *well known* generally regarding induction and undulatory or other electric currents.

1845. Sullivan (Philosophical Magazine) described the production of electric currents by vibration of metal wires, etc., or by the movement of metals in magnetic fields.

1851. Farrar, of Keene, N. H., showed that a reed or armature, mounted near the pole of an electro-magnet, could respond simultaneously to several distinct reed vibrations.

1854. Borseul wrote his famous letter aforesaid, theoretically outlining the electrical transmission of speech. He expressly based his conclusions upon *then well-known scientific facts*. A month later the letter signed "L" appeared (September 28, 1854) in Didaskalia, based expressly upon Borseul's ideas. The writer of that letter made it perfectly clear that Borseul distinctly referred to the electrical transmission of speech—spoken words—and not to mere musical sounds, tones, or notes apart from speech, and he stated the requisite details of a telephone and their arrangement. Borseul was convinced that speech could be transmitted thereby, provided that two vibratory plates of metal could be obtained so flexible, etc., as to receive and deliver the undulations in the air produced by the voice. Reis then was twenty years of age and resident in, or connected with, Frankfort on the Main, where that letter appeared. Bell then would be about seven years old. Reis, within nine years, experimentally demonstrated the electrical transmission of speech, as we shall see later herein. Also we shall see later herein that it was twenty-two years after 1854, and thirteen years after Reis improved his telephone in 1863, and Kemp's exhibited it in use, in Edinburgh, that Bell patented his famous "improvements."

1856. Du Moncel stated the scientific principle that: When an electric current passes through the point of contact of two bodies, the electric conductivity changes with the *change of contact*. Obviously, therefore, if by means of a variable tympanum, as in a telephone, or of a vibrating contact spring or armature such as was used in Faradic coils, the contact between two points in a circuit could be varied, the electric current in that circuit could be correspondingly varied. And observe that a "make-and-break" is not here necessarily referred to, or involved.

1859. Reis sent his papers on "The Radiation of Electricity" to Prof. Poggendorff, who declined same. This is evidence of Reis's intelligent interest in electrical science at that date.

1860. Reis about this time, incited as he subsequently stated by his studies in physical science, "attacked a work begun much earlier concerning the organs of hearing," and "succeeded in inventing an apparatus by which it is possible to make clear and evident the functions of the organs of hearing, with which also one can reproduce tones *of all kinds* at any desired distance by means of a galvanic current," and he named the instrument "telephone."

1861. Reis read his paper, "On Telephony by the Galvanic Current," before the Physical Society, Frankfort, October 26, and exhibited his telephone in use. He made it perfectly clear that he understood the necessary condition for the reproduction of any tone or combination of tones was the setting up of vibrations whose curves are like those of the given tone or combination of tones. (*Vide* Jahresbericht des Physikalischen Vereins, Frankfort, 1860-61.)

Helmholtz made his famous investigations about this time.

Reis clearly aimed at the transmission of spoken words. He did not even begin, as Bell did afterward, to make an electric telegraph with musical reeds. It was an infamous untruth to say Reis invented a mere "musical telephone."

1862. The Reis telephone as a "surprising invention" announced in Didaskalia of May 8. Reis lectured and showed his telephone to the members of the Free German Institute present at a meeting in Frankfort, May 11. (*Vide* Didaskalia, May 12.)

Reis's telephone was referred to in the report by Inspector Von Legat, communicated (1862) to the Austro-German Telegraph Society, and printed in their journal. That report was reprinted in Dingler's Polytechnisches Journal, 1863.

About December, 1862, is the date of the aforesaid exhibition, according to Prof. L. Tait (as near as he could remember) of the Reis telephone at Kemp's. A. G. Bell was then about fifteen years old and a student at the High School, Edinburgh, about a mile distant from Kemp's. Very close relations then existed between Kemp's and the University and High School physical masters. Prof. L. Tait's letter aforesaid states that the exhibition at Kemp's was made "to customers." Certainly, the University and High School masters and pupils were noted customers and constant frequenters of Kemp's, for physical apparatus, materials, and information.

1863. Reis showed how an exquisitely delicate control of a variable resistance in a galvanic circuit might be exercised by the voice when he constructed his improved telephone (see Reis's prospectus in Prof. S. P. Thompson's book, and also Pisko's book, 1865, page 241), having a "platinum spike dipping into mercury" to a greater or less extent, according to the vibrations of a tympanum or membrane when spoken to. Also, by his otherwise variously controlled loose contacts, he proved that he, at least, was master of his subject within the limits of his resources. His telephone in his own hands, and in the hands of others using same rightly, certainly transmitted speech. This I know by using the one Kemp's had.

Albert, of Frankfort, as the authorized dealer therein, made and sold Reis's telephones. It is highly probable that Kemp's obtained their first Reis telephone from Albert direct.

Ladd had a Reis telephone in London. July 4, 1863, Reis showed one of his improved telephones to the Physical Society, Frankfort. September 17 to 24 Prof. Bottger showed a Reis telephone at a scientific meeting in Stettin. In 1863 Muller-Pouillet's notice of the Reis telephone appeared in the "Textbook of Physics."

Some time in 1863, according to my informant, the exhibition of the improved Reis telephone took place

at Kemp's, as aforesaid, at which Prof. L. Tait was present. Certainly, the transmitter was one of the "square box" pattern, with mouthpiece at one side, and tympanum at top, controlling a variable mercury resistance in the galvanic circuit. The receiver was of the knitting needle variety with a box cover.

1864. Shearer, who had conducted the exhibition aforesaid, left Kemp's about this time.

Munzetti is said to have invented the telephone about 1864.

1865. Prof. L. Tait ceased to be a student of medicine in Edinburgh about this year, according to his letter aforesaid. From that he appears to have approximated the year in which the exhibition aforesaid, which he attended at Kemp's, took place. I am satisfied the date of it was 1863, not 1862.

Visko's work, published 1865, describes Reis's telephone. In November, 1865, Yeates, of Dublin, had a Reis telephone which was shown at a meeting of the Dublin Philosophical Society. (*Vide* Prof. S. R. Thompson's book on Reis.)

1866. Kuhm's widely-circulated work on "Applied Electricity" published. It described Reis's telephone. (S. P. T.)

1868. In this year A. G. Bell is said to have moved to America (Urbanitzky).

1873. Koenig described his celebrated acoustic apparatus, and his researches on sound waves. (Philosophical Magazine.)

1874. Early in January the writer hereof first saw the identical Reis telephone transmitter and receiver, which had been used at the aforesaid exhibition about 1867, still lying on a shelf in Kemp's workshop. Then, also, he there met and conversed with men who had been present at that exhibition, and who described same. Unquestionably, that telephone operated without necessary "make-and-break" of the galvanic circuit.

January 14, 1874, Reis died.

Gray's telephone invented. This appears to have caused renewed interest in telephony in America. Gray subsequently took out a patent for a telephone (described page 772, Urbanitzky) which is characterized by a variable resistance arrangement consisting of a metal rod, which dipped into a badly-conducting fluid and was controlled by a vibrating tympanum. This at once recalled to mind Reis's platinum wire dipping into mercury contained in a hollow pillar, described in Muller-Pouillet's work aforesaid, and as used at Kemp's in 1863.

The variation of resistance in the continuous galvanic circuit, used by both Reis and Gray, naturally caused the electric current to undulate in accordance with the undulations of the tympanum used to control the resistance (other things being equal) as per Ohm's law.

Gray's telephone was fiercely attacked after Bell's improvements were patented in 1876.

1875. About this time very thin sheet-iron or steel plates were much used in America for photographic purposes, and known as ferrotype plates. Subsequently, these served excellently for telephone diaphragms (tympani) and superseded the membrane used in constructing the tympani of telephones. The ferrotype plate answered the purpose of the "metall-wand" or vibrating wall, sheet, or partition referred to in Didaskalia as aforesaid, so flexible, etc., that they served the purpose indicated by Borseul. It is not surprising that it occurred to Prof. Trowbridge, of Harvard, about 1875, to try the effect of such thin sheet-iron plates as armatures of electro-magnets.

1876. February 9 Prof. Trowbridge contributed the results of such experiments on induction, and pointed out the advantages of such plates as armatures of straight electro-magnets for certain purposes. (*Vide* Proceedings American Academy Arts and Sciences, 1875-6.)

May 10, 1876, Prof. A. G. Bell contributed to that same academy his "Researches on Telephony," as reported in their Proceedings, N. S., Vol. 4, 1876. Therein he made it clear, by express reference to their names, that he knew that Reis, Legat, Gray, and others had previously been interested in and made advances in telephony. He specially mentioned Gray, who, he said, was reported to have claimed the discovery of simultaneous telephonic production of notes of different pitch. Bell therein claims to have *foreseen* the possibility thereof in 1870, and demonstrated it practically in 1873.

Considering what Farrar had published and demonstrated in 1851, this is peculiar!

The special feature of that paper is Bell's description of his telephone having its transmitter and receiver each provided with a conical aperture (like that of one of Reis's transmitters) and a tympanum or membrane of goldbeater's skin. For some reason the tympanum is not so called, nor is it called a "metall-wand," or diaphragm, or vibrating plates, or armature. It is called a "drumhead" and is 7 centimeters diameter, having a circular disk of thin sheet iron or steel, 1 centimeter diameter, glued to the center, so as to constitute an armature.

Apparently, that paper marked the step immediately preceding the introduction of the all thin sheet-iron or steel tympanum in place of the "drumhead" armed with a small sheet metal center. Bell therein described that telephone as one which had transmitted spoken words with variable distinctness; "as a general rule, the articulation was unintelligible," but occasionally it was "startlingly distinct." This reminds one of the previous performances of Reis's telephone.

Bell's American patent 174,465, of 1876, illustrates the simultaneous telephonic reproduction of notes of different pitch (discovered as aforesaid by Farrar in 1851) with three diagrams, which appear to be copied almost exactly from Reis's famous memoir aforesaid, published fifteen years before in Frankfort.

December 9, 1876, is the date of the British patent for A. G. Bell's "Improvements in Electric Telephony (transmitting or causing sounds for telegraphic messages) and Telephone Apparatus," taken out in the name of one Morgan-Brown. From that date a new era is reckoned in telephony, owing to the astute manipulation of that patent by a powerful combination of influential people.

The above items serve to index the knowledge which was public property regarding the telephone prior to the Bell telephone improvement, British patent of December 9, 1876, and to show how they are connected together naturally in order of time.

Bell made and indirectly sold to the public certain "improvements" or additions to the knowledge which was already public property. There is ample evidence that he knew very fully in December, 1876, what he had to improve upon, as of course all who seek to improve upon anything are properly entitled—if not bound—first to ascertain. He had set himself to improve upon the speaking telephone, and he did improve upon it. He certainly had not to *invent it*, or take credit for so doing. Nor had he to invent undulatory currents of electricity, which were well known and used long before he took out his patents in 1876. Certainly, one of those who knew and used such was Reis, as his writings prove. I perfectly remember they were well known to people educated in electric science long before 1876.

The "improvements" made by Bell turned chiefly upon the addition he made to public knowledge when he demonstrated that a weak electric current, obtained in a then long well-known manner from a small permanent magnet, instead of from galvanic cells, was sufficient to transmit speech over short distances, and reproduce same with reliable fair articulation. So the telephone was made neat and portable. Also, he demonstrated the advantage of the thin all-iron or steel plate as a tympanum or armature, over the membranes previously used, and that his receiver could be used as a transmitter, and his transmitter as a receiver. But the suggestions made at the time tending to represent undulatory currents or their employment in telephony as then in any sense novel were as absurd as it would have been to represent undulatory gas currents or their employment in Koenig's manometric methods as acoustic novelties in 1876. Reis, in 1863, and Koenig, in 1873, both produced undulatory variations upon a continuous current; in the one case electrical, and in the other case gaseous current. Both used a tympanum to collect the vocal sounds.

Having made an important addition to the enormous stock of previously existing knowledge possessed by the public, Bell indirectly sold to the public the right to use that addition in return for monopoly rights for the usual period. Thereupon those monopoly rights were sold by or for Bell in return for a relatively enormous amount of cash. Thenceforth the position of matters was like this: First, the public *owned all the rights* to Bell's "improvements" *absolutely*, but subject to a lease or patent which the public had granted for a term of years to Bell or his assignees, during which term they had a monopoly; second, the assignees who had bought the lease or monopoly from Bell or his representatives, owned that lease for its term of years only, subject to certain conditions; and third, Bell owned the money, for he had sold his rights to the public for a guaranteed monopoly, and that monopoly he had sold for cash. Practically, only two parties remained out of the three to be considered, viz., the public and the holders of the monopoly.

From 1876 controversy and litigation began about the telephone between the public and the holders of the Bell telephone patent monopoly, to settle the question as to what that particular monopoly involved. Clearly, Bell or his representatives could have conferred no valid title upon the assignees of his monopoly, greater than the title Bell had himself, and Bell never had, nor could he possibly have had, any legal valid title to monopolize by patent or otherwise anything that was public property prior to the date when he applied for his patent. In fact and in law, he never had as regards the telephone, and could not have, a valid title to aught that was *not novel* and *his own discovery*, or *property*.

Naturally, the assignees, finding themselves the holders of a monopoly for which they had paid, and still would have to pay, a relatively enormous further sum, construed their title as widely as possible, because they were under the necessity of reimbursing themselves during the continuance of the monopoly, if possible, for their great outlay, and with enormous percentage profit. No wonder, therefore, the Reis-Bell controversy raged furiously, and litigation flourished. No wonder that the period after 1876 was ill suited to the calm discussion of telephone evolution, and that it remains to this day hidden to a great extent under a vast cloud of the *suggestio falsi* and *suppressio veri* raised by hireling experts, whose evidence, as recorded in the law reports of the public papers after 1876, remains as a fitting memorial of their ignorance and ingenuity in misrepresenting facts. Whether the astounding judicial decision *re* telephony could have been given after 1876, if there had been a distinct knowledge of the first public exhibition of a speaking telephone in Britain in 1863, of the special conditions of environment, and of the facility of advertisement connected with same, given to the courts after 1876, is doubtful. But there is no doubt that Kemp's public exhibition of Reis's speaking telephone, about 1863, is one of the most important links in the chain of evolution of the speaking telephone after Reis had practically invented it and expressly left it open to "improvements."

In conclusion, I wish to acknowledge my indebtedness to Prof. S. R. Thompson's work aforesaid and to the SCIENTIFIC AMERICAN for various references, and have much pleasure in referring to them for further particulars. Also, I wish to make it clear that I never was connected in any way with the telephone business or litigation, and I do not know, and to the best of my knowledge I never saw, any one of the persons whose names are mentioned herein. I have no personal interest for or against any of them.

A representative of the SCIENTIFIC AMERICAN in Washington, D. C., states:

"Some years ago, probably from six to eight years, he heard Prof. Alexander Graham Bell deliver a lecture, or rather a talk, on how he came to invent the telephone. It was delivered before the men's society of the Church of the Covenant, this city, was attended by several hundred people, lasted for a period of about one hour and three-quarters, and was intensely interesting from beginning to end. Prof. Bell spoke of his early boyhood in Scotland, of his interest in elocutionary matters at that time, and of his youthful ambition to become a professional musician. He passed on to a description of his coming to this country, and of his becoming interested, with his father, in devising some means whereby speech could be rendered visible, and thus be made available for transmission of ideas to the deaf. He stated that he and his father had become satisfied of the impracticability of teaching the deaf to read the lips, and noted now how badly they had been mistaken, in the light of developments, in view of the common practice of reading the lips at the time the lecture was delivered. He spoke of his early experiments in the neighborhood of Boston in seeking to devise some apparatus whereby the vibrations of the human voice could be caused to operate, in some manner, upon a visible device, so the deaf could read speech by sight. It is recalled that he stated that this led to his invention of the telephone. He stated that he had never been much of a student of electricity, but had, to a great extent, studied the science of sound, and that he was satisfied that if he had been more of a student of electricity, and less a student of sound, he would never have invented the telephone. He also stated that after he had conceived of the idea of the telephone, he found he did not have the electrical information necessary to develop it, and he came on to Washington and explained his ideas to Prof. Henry, then at the head of the Smithsonian Institution. He told Prof. Henry of his difficulties, and asked his advice as to securing the aid of electricians, as he did not have the necessary electrical information to develop the invention. He stated that Prof. Henry's advice was 'to get it,' referring to his lack of electrical information, and that he then proceeded to study the subject of electricity to such an extent as to enable him to complete his invention of the telephone."

[Alexander Graham Bell was born in 1847, and was educated in Edinburgh and in the London University. His father, Alexander M. Bell, was from 1843 to 1865 lecturer at the Edinburgh University. This covers the period when Mr. Sharp thinks the Reis telephone was exhibited at Kemp's Edinburgh establishment.—ED.]

HOW FOOD IMPORTS ARE INSPECTED.*

IT may be of interest to give a brief outline of the manner in which the inspection of food products offered for import into the United States is effected. The law authorizes the Secretary of Agriculture to ask the Secretary of the Treasury to secure samples from any invoice of food products which he may think demands inspection. In harmony with this request the Secretary of the Treasury, through the proper officials at the ports, issues a notice of detention to the consignee of the invoice, and at the same time secures the samples requested. These samples are sent to one of the three official laboratories—which are at present established at Washington, New York, and San Francisco—where the examination takes place. If the samples in question are found to be of a nature contrary to the provisions of the law, the consignee is at once informed of this fact and an opportunity is given him to submit evidence of such nature as he may desire to prove the fitness of the article for import. The evidence may be submitted either in person by the consignee or by his attorney, or in writing. This evidence is carefully considered, and every opportunity is afforded the consignee to prove the fitness of his wares for entry. If after the investigation is completed we are satisfied that the articles are of a nature which is not forbidden by the law, the detention is suspended and the articles are released, and take their usual course. If, however, the investigation shows that the articles, as had been suspected, are unsuitable for importation, the Secretary of the Treasury is requested to secure a reshipment of these articles beyond the jurisdiction of the United States. If this is not done within ninety days from the time the notice is received, the Secretary of the Treasury, under authority of law, is entitled to take possession of the articles and destroy them.

It so happens that even with every effort which may be made to fully inform importers and exporters of the character of the law, many invoices are sent, innocently on the part of both importer and exporter, which are found to be unfit for importation. In these cases as great facilities as possible are given the importer to comply with the provisions of the law so as to minimize the extent of the delay and the loss which he must suffer. It is evident that as the experience in

* From report of Dr. H. W. Wiley in the year book of the Department of Agriculture.

the execution of the law is increased, and as importers and exporters are better informed in regard to its provisions they will be better able to comply therewith. In fact, much of the friction and delay which were at first experienced in the execution of the law have been already removed, and it must be said, to the credit of the importers, that the great majority of them express themselves as heartily in sympathy with the purposes and processes of the law. It is largely by the help of the sympathetic collaboration of the importers that the execution of the law has been made as effective as it is.

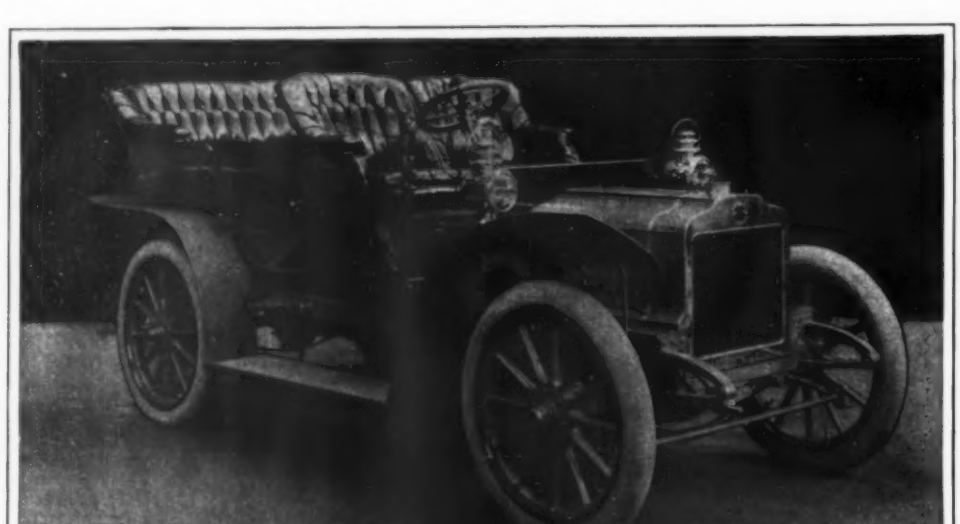


FIG. 1.—A 20-HORSE-POWER RICHARD-BRAZIER TOURING CAR.

THE WINNING AUTOMOBILES IN THE SIXTH INTERNATIONAL CUP RACE FOR THE BENNETT TROPHY.

I. THE RICHARD-BRAZIER CAR.

THE machine which, driven by the same driver who piloted it to success last year—Leon Théry—has once more won the sixth international cup race under the skillful guidance of the same driver, is described herewith. The race was held on July 5, over a very hilly and sinuous course in France, known as the Auvergne circuit, and it resulted in the victory of the 96-horse-power Richard-Brazier racer.

The racer built this year for the Gordon Bennett race follows out in almost every detail the lines of the standard touring car of this make. The one important exception is the employment of a chain drive to the rear wheels from a countershaft placed across the chassis at the rear of the transmission box, instead of the bevel-gear drive and live rear axle used on the standard touring car. As this is an ordinary construction and is not that usually put out by the makers of the car, we shall describe in preference the construction used on the regular model.

The 1905 cars have a long pressed-steel frame, reinforced by a tubular sub-frame of great strength upon which is mounted the transmission gear. The main frame is 85 centimeters (33.46 inches) in width, and it is not cambered at the front. The tread of the standard car is 1.37 meters (4½ feet) and the wheel base 8 feet 2 inches, a length necessary on account of the side-entrance tonneau. A new form of axle having T-shaped ends is used in front. As shown in Fig. 3, the upper part of the T rests at *m* on a horizontal row of balls; this is the part that carries the load. The lower part is inserted in a conical bearing *n* with a play of about a millimeter; this is the part that guides the position of the T under its load.

A good idea of the Richard-Brazier motor can be had from the half-tone cut, Fig. 5. The motor is hung rather low upon the chassis, a feature which makes it easily accessible. All the valves are mechanically operated. The inlet valves are placed in separate chambers, *I*, on one side of the motor, and the exhaust valves in similar chambers, *E*, on the opposite side. Both exhaust and inlet valves are operated by separate cam shafts placed symmetrically on each side of the motor and driven from the crank-shaft by incased fiber gears. The Sims-Bosch magneto, which is placed beside the two pairs of cylinders in the center of the motor and on its exhaust-valve side, is also directly driven by a gear meshing with the gear that drives the exhaust cam shaft and placed directly above it. The time of the spark is not varied save in starting the motor. When the starting handle is pushed into place this automatically retards the spark, and as soon as it is withdrawn, the spark is set at the one fixed point. As, however, the intensity of the current produced by the magneto increases with the speed of the latter within practical limits, and as the ignition is quickened in proportion as the temperature and volume of the spark increase, an automatic spark advance is thus obtained, according to the increased speed of the motor. The make-and-break igniters are shown in the illustration. The current is conducted to the insulated poles, *G G G G*, through the wire, *J*, and the rod, *H*, which is incased in fiber. The igniters are operated by push rods, *B*, which shove up a small cam, *C*, on the movable stem, *A*, which contacts against an insulated pole, *G*, within the cylinder. The instant the push rod, *B*, strikes the cam, *C*, the igniter points make contact inside the cylinder. As soon as *B* slips out from under the cam, *C* (it being pushed out as it rises by an eccentric on the hub of the lever to which rod *P* is connected), the igniter points within the cylinder quickly separate and *C* falls back to the position shown. It is assisted in doing so by the small spring, *S'*, which pulls on the lever arm, *D*, forming part of the cam. The inlet pipes to the two pairs of cylinders are seen at *K K*, while the hot-air inlet to the carbureter is shown between the cylinders at *L*. The two throttle valves, *T T*, are placed between the pairs of cylinders and are connected to a single rod which is operated by a lever in the steering wheel by means of the connection, *Y*, at the base, *X*, of the steering column. A centrifugal ball governor at the front of the motor is also connected to this rod. The flywheel of the motor is seen at *Z*. *U* is the universal joint and *V* the bevel gears that drive the oiler on the dashboard. The priming cups, *p p p p*, are seen on top of the cylinders.

The motor is cooled by water which is circulated through the water jacket and the finned tube radiator on the thermo-siphon principle. The large inclined water pipes leading from the top of the radiator are seen at *W*, while the pulley for the fan belt is shown at *R*. The radiating surface has been increased considerably on the 1905 cars, while an improved form of fan having blades which are thinned out and enlarged toward the end after the manner of an ordinary propeller, is used. The blades are made of forged steel which is tempered and then hardened. The same process is used in the manufacture of the springs of the car. The flooring back of the motor has been raised as much as possible in order that the circulation of air under the vehicle may be very intense.

The construction of the carbureter can be seen from the diagram, Fig. 4. It consists of a float-feed chamber containing a metal float, *F*, which slides up and down around a central stem. Gasoline, which enters through a fitting, *f*, on top of the carbureter, is shut off by a needle valve attached to the top of the float. A settling chamber, *m*, below the float chamber, is provided with a pet-cock for draining any dirt or water out of the gasoline. The primer for holding down the float and flooding the carbureter is shown at *n*. Gasoline flows from the float chamber through the pipe, *C*, into the spray nozzles, *E*, and is maintained at the level shown by the dotted line passing through the points of these nozzles. The air is drawn in through the pipe, *F*, and, as it rushes past the nozzles, *E*, it draws the gasoline from these two nozzles. The two jets strike each other and impede each other to a certain extent. This checking of the flow of gasoline becomes more pronounced as the suction of the motor increases, and thus tends to produce a gas of constant richness at high speeds as well as at low ones. Nevertheless M. Brazier observed that when the motor was speeded up the richness of the mixture increased. The result was an excess of heat in the water jackets. To remedy these defects M. Brazier added to the carbureter an automatic valve, *J*, which only opens and lets in additional air when the motor exceeds 1,000 revolutions per minute and which a piston, *K*, keeps from vibrating. The piston, *K*, has no opening and the air filters slowly in one direction or the other along its walls. The exhaust is run into a muffler placed across the rear of the vehicle and the outlet of which consists of two flattened pipes extending outward and backward at the rear of the two driving wheels. The jets of exhaust gas keep down the dust raised by these wheels in a very efficient manner. The motor is oiled by an automatic device mounted on the dash-board and consisting of a box filled with oil and having a row of small pumps whose pistons, operated by means of a spring on their suction strokes, draw in the liquid. The pistons are forced outward by means of a mechanically-moved finger, and they force the oil into the different oil pipes running to the motor. This oiler is operated by the vertical shaft having a universal joint *U*, and bevel gears, *V*.

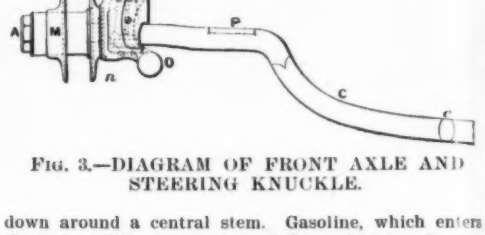


FIG. 3.—DIAGRAM OF FRONT AXLE AND STEERING KNUCKLE.

FIG. 2.—CHASSIS OF STANDARD 20-HORSE-POWER RICHARD-BRAZIER TOURING CAR.

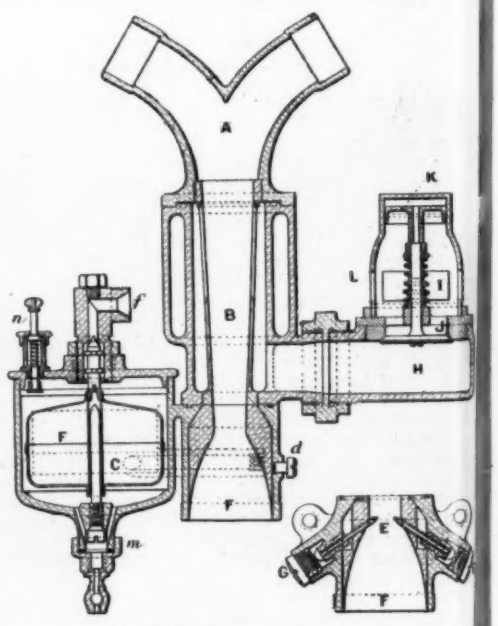


FIG. 4.—CROSS-SECTION OF CARBURETER.

The transmission is mounted upon ball bearings; but these bearings are not run in oil. A diagrammatic view of the transmission is shown in Fig. 6. M. Brazier has reached the conclusion that as long as his cars are being equipped with ball bearings, constructed with the greatest precision, it is useless to compromise this precision by allowing a chip of steel or a bit of metal to be carried into the bearings by the oil. The bearings of

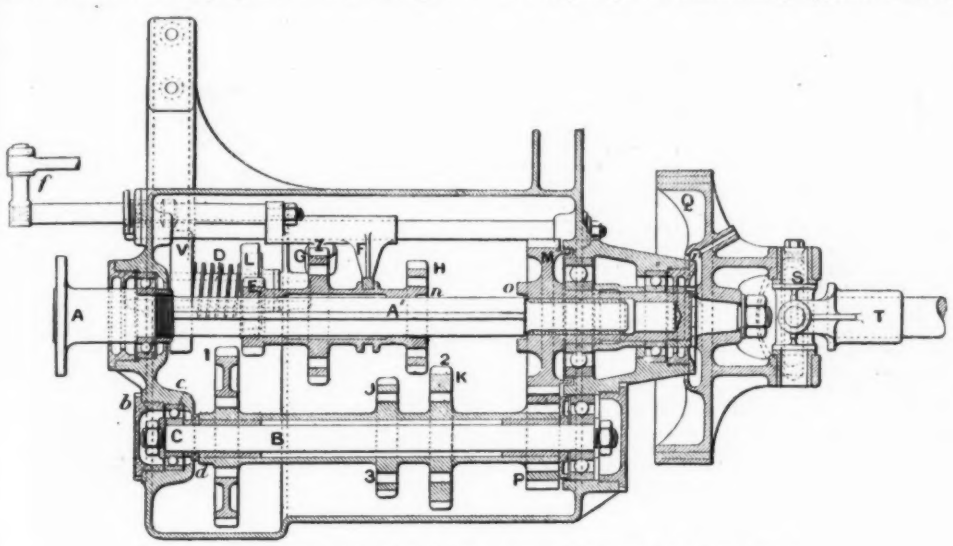
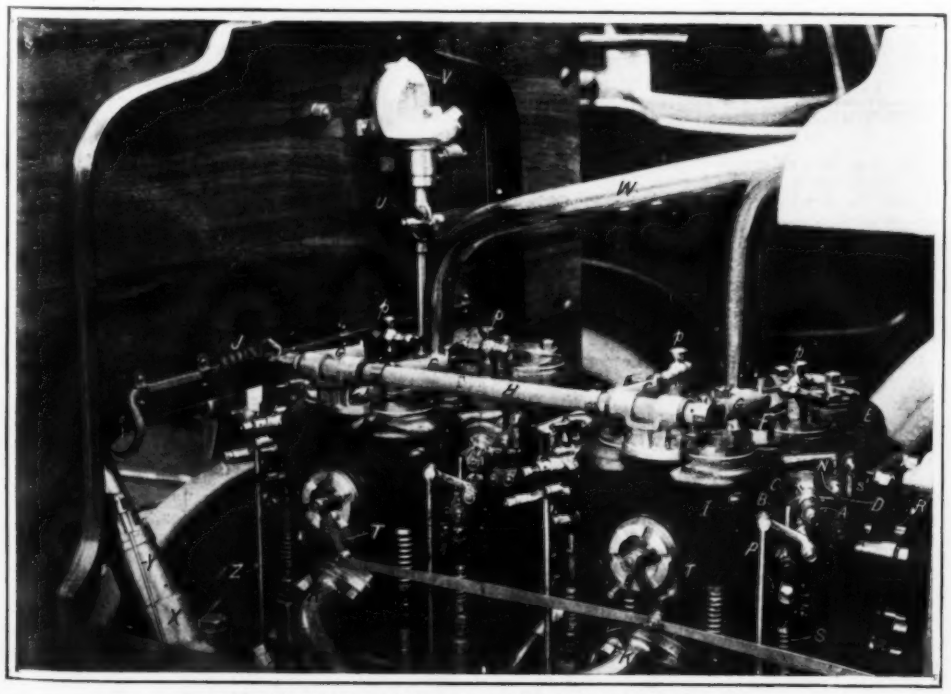


FIG. 6.—PLAN OF TRANSMISSION OF RICHARD-BRAZIER CAR.

the Richard-Brazier transmission are therefore placed on the outside of the gear box and are maintained in position by a threaded plug (see *b c*, for example, in Fig. 6). Only the small amount of play that exists at *d*, between the shaft and the sides of the bearing case, allows the very minute quantity of oil needed by the bearing to ooze into it.

The transmission has four speeds obtained as follows: The first speed is had by the meshing of pinion, *E*, with gear 1, and by pinion *P* driving gear *M*. The last two gears are always in mesh. The second speed is through *H K P M;* the third, through *G J P M;* and the fourth, or direct drive, through the meshing of the jaw clutch *n o*. The reverse is obtained by the roller, *Z* (carried on the same shaft as *f*) pushing the pinion, *L*, to the left until this pinion meshes with gear, 1, and the pinion, *E*, comes into engagement with *V*, which is a fixed pinion attached to *L*. The reverse is thus obtained through the double intermediate pinion *V L*, as *E* drives *V* and *L* drives gear 1 in the reverse direction and at a slower speed than when pinion, *E*, is in mesh with it. The gears are all pressed onto the shafts by hydraulic pressure, and afterward pinned in place, in order to do away with any mishaps from pieces of metal, such as the head of a rivet, for example, breaking off and becoming jammed in the gears.

The clutch has been simplified and improved over



The make-and-break igniters and other parts are plainly visible in the above illustration.

FIG. 5.—THE FOUR-CYLINDER MOTOR OF THE RICHARD-BRAZIER TOURING CAR.

that used last year. A new point is the use of a locking device to keep the clutch from slipping, formed of four steel rods which fit into sockets and which are made to lock the clutch after it has been thrown in. The new form is shown in Fig. 8. The motor shaft carries on its prolongation, *E*, the cone, *V*, which is mounted loose on the shaft and revolves on a copper sleeve. The spring, which is placed inside the sleeve, pulls, through its rear end (which is furnished with a ball thrust bearing) on the end of the crank shaft, and at its other end it pushes the cone into the flywheel. By this arrangement there is no thrust produced on the motor bearings. The sleeve on which the cone is mounted has a collar in which are placed suitable ball bearing shifters, *D D*, mounted on two pins placed diametrically opposite each other and capable of being moved outward (to the right) by means of two levers, *B B*, mounted on the shaft, *F*. A pedal extending upward, and also mounted on this shaft, when it is pushed forward by the foot rotates the shaft slightly and causes the levers, *B B*, to withdraw the clutch, *C*, from the flywheel, *V*, as they move outward the ball bearing pins, *D D*, that are engaged in the clutch collar. The spring, *P*, is stretched slightly while the clutch is out. This arrangement has two very great advantages, viz., that of furnishing a cone which, mounted loosely on the shaft of the motor, centers itself perfectly—a condition which is of the greatest importance to the proper adherence of the clutch; and that of suppressing the square of bronze found on the former type of clutch, and the partial sticking of the same on the motor shaft that is liable to occur at each operation.

The rear axle of the standard Richard-Brazier touring car is shown in one of our illustrations. The bevel gear case is shown open and the driving pinion can be seen in mesh with the large bevel gear which is fastened to the casing of the differential. The left-hand driving shaft is seen passing through the casing and the outer sleeve. The end of this shaft is not seen in the illustration, but that of the right-hand driving shaft is visible. As can readily be seen, the shaft is squared where it fits into the hub of the wheel. The axle is fitted with ball bearings at each spring block. *M* is the incased universal joint, and *N* is the ball bearing upon which the pinion shaft, *p*, revolves. The illustration shows the method of opening the gear case and the ease with which it is possible to get at the bevel pinion and replace the same if at any time this is necessary.

The racer which won the trophy on the 5th instant had a wheel base of 2.65 meters (8.69 feet) and a tread of 1.25 meters (4.1 feet). Its weight was 970 kilogrammes (2,138½ pounds) and the motor developed 96 horse-power at 1,200 revolutions per minute. The bore and stroke of the motor were respectively 160 and 140 millimeters (6.299 and 5.511 inches). The car was fitted with a three-speed transmission, the only other differences being that a countershaft and chain drive to the rear wheels were employed in place of the shaft drive illustrated herewith, and that a centrifugal water-circulating pump was also fitted. The racer had 875 x 105-millimeter (34.44 x 4.13-inch) tires on the front wheels and 880 x 120-millimeter (36.64 x 4.82-inch) tires on the rear ones. It was equipped with the Truffault suspension—a device which checks the rebound of the spring when the car is traveling over a rough road.

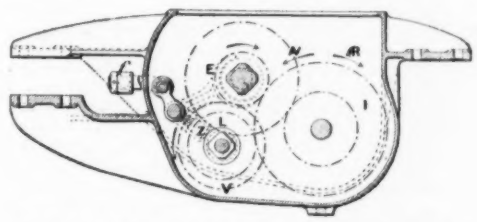


FIG. 7.—END ELEVATION OF GEAR BOX, SHOWING REVERSING GEARS.

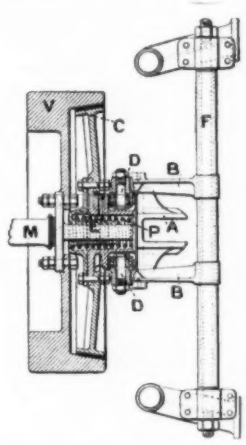


FIG. 8.—CROSS-SECTION OF CLUTCH.

ANCHOR ICE: WHAT IT IS.*

THERE is still a difference of opinion as to how this anchor ice grows; how it first forms; but I think when we consider the amount of heat which is lost from the surface of a river by radiation and the fact that much of this heat can penetrate through the water, that we must admit that radiation plays an important part. When we consider further that this anchor ice is formed only at night when the radiation from the earth is a maximum, that as a rule it never grows under a bridge or under any object which would reflect the heat rays back again into the water, and when we consider that anchor ice apparently grows more rapidly on dark rocks than on light rocks then we must admit there is strong suspicion that radiation plays an important part in its formation. That anchor ice is built up as well by the freezing to the bottom of frazil crystals goes without saying. It could not do otherwise.

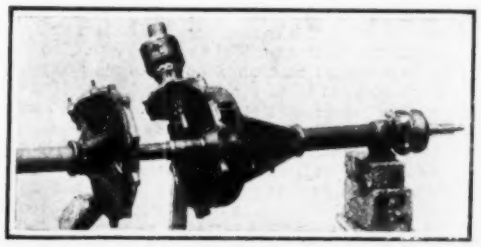


FIG. 9.—REAR AXLE WITH BEVEL GEAR CASE APART.

These surface currents carry down the fine pieces of ice, which passing across the layer of anchor ice which may have formed there by radiation become attached, and we have then great thicknesses built up in a single night. Anchor ice is formed partly by radiation and partly by the sticking to the bottom of these frazil crystals. Anchor ice, during a severe spell of weather, when it is cloudy by day and clear by night, attains a thickness of several feet, such that a pole or a stick placed on the ice will sink into it to considerable depths. When the sun rises it has been noted for a long time that these masses rise to the surface. The boatmen are very chary about going across an open channel when the sun is bright, for these masses come up in great quantities. As soon as the sun gets at a sufficient angle so that its rays penetrate the water, they pass

* Abstract of a paper read before the American Society of Mechanical Engineers by Dr. Howard T. Barnes.

through the water and ice, warm the bed of the river and warm the water in contact with the ice. The ice rises with a characteristic hissing noise several feet above the water and then falls back turning white as the water drains out of it. It floats low in the water because it is saturated and waterlogged just as sawdust will float lower in the water than an equal mass of solid wood. The fact that these anchor ice masses float lower in the water than a similar weight of packed ice would, has given rise to the opinion that anchor ice was ice denser than normal and therefore held down by its own weight. There is no evidence whatever to show that ice of a greater density than normal exists and we therefore disregard that idea as being entirely untenable. Ice at one particular density is formed and only one. The reason of anchor ice being fastened to the bottom is that it is actually frozen there. As evidence of its buoyancy, large masses of rock are sometimes brought up with the anchor ice and carried down the river. Anchor ice will carry large boulders which fill up the channel of the river, and that is one thing the Montreal harbor commissioners have to contend with in the harbor there. They have annually to remove a large amount of rock and boulder carried down by the anchor ice. This anchor ice when it comes up becomes disintegrated and is carried down with the currents, thus aiding the frazil in causing the damming up of the channel.

Now it was the problem set me by the Harbor Commissioners to determine if possible what were the relations between the temperature of the water, if any, and the formation of anchor ice on the bottom, and the peculiar agglomeration of frazil crystals that takes place during very cold weather. It is a great difficulty that the engineer has to contend with in clear water with wind agitation that these little harmless particles grow in size very rapidly and form hard masses to which other crystals immediately adhere. Under certain atmospheric conditions ice agglomerates very rapidly and objects placed in the water become rapidly coated with ice. It is a common phenomenon that if one lowers a bit of iron or metal into the water when the water is in this state the iron will freeze at once to the bottom or to whatever ice it comes in contact with. Mr. Keefer, who has done so much in studying ice formation, has observed in going across the St. Lawrence River during an exceedingly cold day when the water was very dull and appeared to be completely laden with frazil crystals, that he could feel the resistance to the motion of his paddle as they attached themselves to it, sticking out at right angles like long needles.

We designed a suitable form of resistance thermometer and undertook in the winter of 1896 to determine if possible any variation in temperature from the freezing point under the surface ice. Accordingly, a shanty was provided for the instruments in a suitable spot opposite Montreal, and in February of that year the instruments were taken out and observations commenced. We wanted to know how much the river differed from the freezing point. The method of observation which was adopted was a differential one, determining the temperature of the river by a difference from a carefully prepared mixture of ice and water. A very sensitive galvanometer was used and any changes were at once detected by either a change in the galvanometer or a change in a suitable measuring wire, the wire having a scale, as I mentioned before, of 8 inches to the degree Centigrade. Now the difficulties encountered were very great, and I may say although about five weeks were occupied in these measurements only half a dozen measurements could be obtained, for troubles arose from the breaking of the thermometer, troubles arose from the breaking of the galvanometer owing to the roughness of the shanty, and other troubles arose from the varying magnetic field due to the heating apparatus.

The results of these observations have been published, and it was found during the entire time, with a variation of air temperature from 28 below to 40 above, the river under the surface ice never varied as much as one one-hundredth of a degree from the freezing point; that during the entire time of the observation no deviation as much as that could be measured and as a rule the variations were within a few thousandths of a degree. A severe spell of cold weather would cause a slight drop in temperature and *vice versa*.

The tube of the thermometer passed out through the shanty to the river, from a shelf where rested the galvanometer and measuring instruments, which I may say were of priceless value as they were unique of their kind. The bulb of the thermometer was incased in lead 6 inches long connected with wires incased in lead 100 feet long which passed up into the shanty. First of all an exact balance was taken between the resistance of the two bulbs when both were immersed in the ice and water mixture in the shanty. The watchman then carried the bulb directly out and put it into the river, and after a few moments another balance was obtained. It was possible to obtain at once a change in reading giving by reduction of the temperature.

The following winter, observations were made at the Lachine Rapids because it was considered that possibly the water under the ice opposite the city came to the freezing point because it flowed so far under the surface sheet of ice. The shanty provided was smaller again than the one we had before and there we had further difficulties. It was placed on the coffer dam of the Lachine Hydraulic Company, then under construction, and just at this point the water was running at a very high velocity. This sheet of water is entirely open and flows rapidly from a point about five miles above the dam and sweeps around this curve with a tremendous velocity and a great deal of surface agitation.

Table I. shows the results obtained in these measurements, with water temperatures, clearness of sky, wind and miles per hour between the rapidly flowing current and the quiet back water just below the point of the dam. As the current was swept around the dam, some of the water came back and formed an eddy.

This table illustrates one thing very clearly, that the

TABLE I.

Date.	Air temp. Fahrenheit degrees.		Sunshine in per cent. if possible.	Sky.	Wind in miles per hour	Difference from freezing point in degree Centigrade	
	Max.	Min.				Current.	Quiet water.
Feb. 3 ..	+ 20	+ 10	89	Clear	28 6	. 0	.....
" 5...	+ 32	— 3	88	"	9.7	.....	+ 0.0215
" 7...	+ 38	+ 27	00	Raining	13.1	+ 0.0197	+ 0.0182
" 8....	+ 34	+ 28	00	"	16.3	+ 0.0647	+ 0.0415
" 11...	+ 18	— 3	94	Clear	6 5	+ 0.0137	+ 0 0151
" 12..	+ 11	— 2	00	Stormy.	21.1	— 0.0005	— 0.0008
" 13..	+ 17	0	100	Clear	15.1	.....	+ 0.0186
" 15...	+ 35	+ 24	67	Clear to cloudy	17.6	+ 0.0280	+ 0.0423
Mar. 1..	+ 22	— 10	25	Clear to cloudy	16 8	.....	0

margin between the disintegration of the ice and the formation of the ice is exceedingly narrow. That it is only a few thousandths of a degree. These high temperatures are all influenced by the sun's rays being absorbed in the water.

Table II. is reproduced to show the effect of the sun's rays in the water.

When the air temperature is sufficient to cause a rapid abstraction of heat, the process of freezing goes on and the temperature falls slightly below the freezing point. The reason for this is probably that ice only crystallizes at a fixed rate. If we abstract heat rapidly enough and the water cannot freeze rapidly enough to keep the temperature up to the freezing point the only thing that can happen is that the temperature must drop a little below. When the reverse process takes place and heat is applied to the mass of water, the ice will not be able to melt fast enough to keep the water cool, and the mass will in consequence be a little above the freezing point. The less the amount of ice present the more the temperature will rise or the lower the temperature will fall for any given rate of gain or abstraction of heat.

Evaporation would have quite a considerable influence on the loss of heat and consequent formation of ice, but it is probable that it is small compared to the other agencies at work. At night we have a clear sky

TABLE II.

Date.	Sunshine in p. c.	Locality.	Diff. from 0° C.	Air tem.
Feb. 13	100	5 ft. from surface (bottom).	+ .0186	+ 16° fahr.
"	"	1 ft. from surface.	+ .0474	"
"	"	8 in. from surface.	+ .0741	"
"	"	Shallow current.	+ .0461	"
Feb. 15.	67	5 ft. from surface.	+ .0423	19° sky clear
"	"	8 in. from surface.	+ .0819	"
"	"	Just under edge ice.	+ .0282	"
"	"	Deep current.	+ .0280	"
"	"	Bottom of back water, sun clouded.	+ .0112	37° Cloudy.

practically free from water vapor, and, therefore, the heat is almost unabsorbed. That is, it passes through the layers of air without any reflection back again. On a cloudy night the rays are reflected back into the water. General calculations can only be made under given conditions. The average heat we receive from the sun is about 0.05 calorie per square centimeter per second.

We know about what the surface of a black body will radiate or how much heat will be given off. Such surface radiation is about 0.0003 calorie per square centimeter per second per degree difference of temperature.

That seems very small, but if you consider what the radiation is from the large surface of a river it seems much greater.

Suppose we make a calculation of how much heat would be radiated at 32 degrees Fahr. to air of 0 degrees Fahr. We would find if we applied our calculations that about four and one-half pounds of ice would be formed per square yard per hour. Now if we consider the radiation from the water surface at night into space at absolute zero then we would get 80 pounds per square yard per hour formed. So you see how very much greater the radiation would be on a clear night and what a large proportion of ice would be formed. That is merely by radiation. Of course these calculations are based on assumptions which very seldom hold rigidly in actual conditions. From the river bottom there would be a smaller proportion of ice formed. We would get an inch of solid ice formed in about six or six and one-half hours.

The effect of pressure has a strong bearing on the question of the state of the ice. The effect of pressure is to lower the freezing point. On hundred and fifty atmospheres lowers the freezing point 1 degree Cent. One foot of water-pressure would lower the freezing temperature then about 0.0022 degree Cent., which would be about 0.0004 degree Fahr. This means that the undercooled surface layers if submerged deep enough would be at or above their freezing point. The ice crystals which on the surface would stick together from the fact that they were at temperatures below their freezing point would not stick together at a great depth.

The effect of falling water is to generate heat. One foot of fall would raise the temperature 0.00131 degree Fahr., or 0.0007 degree Cent. You see that water falling rapidly would have an important influence in counteracting the slight undercooling. But it would have to fall rapidly to counteract the cooling effect of air at or below the zero point. In the case of water flowing several feet in several hours this effect of heating by fall would be negligible. But if it was falling rapidly over say a head or a natural fall it would have an important influence. But it would be much smaller than calculation on account of the amount of mixed air; and the exact influences could only be determined by measurement.

CONTEMPORARY ELECTRICAL SCIENCE.*

THE FARADAY EFFECT AND THE ELECTROMAGNETIC THEORY OF LIGHT.—H. T. Eddy discusses the experiments of Mills, who succeeded last year in exhibiting the different velocities of two opposite circularly polarized beams in bisulphide of carbon along the lines of force in a magnetic field, and uses the results to controvert the theory of the Faraday effect developed by Rowland, who attempted to account for the twisting of the plane of polarization of plane polarized light while being propagated along the lines of force in a magnetically active medium by the action of the Hall effect in the medium. The author shows that, in case of circularly polarized light, the amount of change in velocity due to the magnetic field is expressible as a lower power of small quantities than in case of plane polarized light, and consequently the magnitude of the change in the former case is large compared with the latter, and in fact varies as the square of the latter; and while the latter may be quite beyond the range of observation, the former may be well within it as the experiments of Mills have proved. He further shows that the differential equations based on two different electromagnetic hypotheses as to the action of the medium in producing rotation or twisting of plane polarized light in a magnetic field involve an equation expressing the relation of the velocity of this kind of light at zero field to its velocity in the given field. On the hypothesis of orbital motions of ions the differential equations show that the field would cause a decrease in the velocity of plane polarized light during the twisting; while on the hypothesis of ions having a motion of translation across the field, the differential equations show that the field would cause an increase in the velocity by an amount one-third as great as the decrease just mentioned. This increase or decrease is of the second order of small quantities, and is so minute as to be at present beyond the range of observation, varying, as it does, as the square of the observed change produced by the field in the velocity of circularly polarized rays. MacCullagh's differential equations involve practically the same decrease of velocity by the medium as those based on orbital motions of ions. A moderate amount of absorption in the medium would not practically modify the conclusions true for perfectly transparent media on either hypothesis. A crucial experiment to decide between the two hypotheses would require apparatus of greatly increased sensitiveness.—H. T. Eddy, Physical Review, April, 1905.

ELECTRIC CHARGE OF THE SUN.—S. A. Arrhenius makes some calculations of unusual interest in connection with the electric properties of the sun. Starting from Wilson's observation that drops are more easily condensed on negative ions than on positive ions, he shows that the particles repelled by the radiation pressure of the sun will be chiefly negative. The Maxwell-Bartoli pressure has a maximum when the diameter of the particles, supposed of density 1, is 80 $\mu\mu$ (8×10^{-5} centimeter.) Hence these particles will be chiefly concerned in the conveyance of negative electricity from the sun outward. They will be repelled by the sun with a force 2.5 times their gravitational attraction, so that they will be repelled by a net force 1.5 times that of gravitation, and will reach the earth in two-thirds of the time required by a body to fall from the earth into the sun. They will reach the earth in 45.9 hours. This figure agrees exceedingly well with that found by Ricco for the difference in time between the passage of a great sunspot over the central meridian of the sun and the appearance of a magnetic storm. This repulsion and emission of negative particles is checked by the positive charge acquired by the sun, and must cease altogether when the slope of potential at the sun's surface becomes 48 volts per centimeter. This consideration enables us to fix the maximum possible charge of the sun. It comes out as 25.5×10^{9} coulombs, or enough for electrolyzing 24 tons of water. Since there is a continual emission, there must be some compensation, and the author finds this in the free electrons distributed throughout space, which, being of extremely small diameter, are not subject to the effects of radiation pressure. He proceeds to calculate the conditions on which these will be attracted by the sun. Their orbits, like those of comets, will depend upon their speed, but it may be assumed that their speed is not very different from that of the electrons emitted by negatively-charged bodies under the influence of ultra-violet light. The author thus calculates that the space drained of electrons by the sun would have a radius of 0.063 light-years, or one-sixtieth of the distance to the nearest fixed star. The space drained is proportional to the sun's positive charge—i. e., to its defect of electrons. Thus the compensation is automatic, and there is a constant and stable circulation of negative electricity in the solar system.—S. A. Arrhenius, Terrestrial Magnetism, March, 1905.

* Compiled by E. E. Fournier d'Albe in the Electrician.

SCIENCE NOTES.

The public problems of agriculture have been slow to gain recognition. The agricultural questions that we customarily discuss are those of the individual farmer. The burden of our teaching has been that the farmer must be a better farmer. Only in recent years has it come to be fully recognized that agricultural problems are of the greatest national and governmental significance. Consider how recent is the Land Grant Act, the secretaryship of agriculture in the President's cabinet, the experiment station act, the origin of a definite farmers' institute movement, the development at public expense of fertilizer and feed controls and other policing policies, the making of liberal grants of public money for specific agricultural uses.

Public health science had its rise and a considerable development in the eighteenth century. Before that time numerous procedures tending to protect or promote the public health had, indeed, at one time or another existed, but these were largely empirical and quite as often directed to the convenience of mankind as to their sanitary safety. In this class belong the Mosaic code; the water supply introduced into Jerusalem by Hezekiah; the sanitary engineering of Empedocles; the *Cloaca maxima;* the water supplies of ancient Mycenæ and of Rome, and all the earlier, and too often futile, forms of quarantine. Even the art of inoculation for smallpox was only an ingenious knack introduced from the East, where it had been long used empirically, and although it is a public health measure now of the utmost interest and capable at the time of great practical service, it had until recently no scientific basis, but belonged in nearly the same class as the amulets and charms, the prayers and incantations, of the superstitious.

We have really not endeavored, as a people, to solve our technical agricultural problems until within the present generation. We have escaped the problems by moving on to the West. Thereby we have fallen into the habit of treating symptoms rather than causes, as the policeman does when he orders the offender to "move on," and leaves the real difficulty for some one else to solve. Even yet, farmers are moving on to find land that is not depleted, and regions free of blights and pests. The real development of agriculture lies in developing the old areas, not in discovering new ones. When virgin land can no longer be had, scientific agriculture will be born. An isolated island develops something like a perfected agriculture, as one may see in Bermuda or Jersey. The earth is an island: in time it will be developed.

It was not until the middle of the eighteenth century, namely, in 1767, that Sir George Baker, by the use of the methods of pure inductive reasoning, made the first scientific discovery in public health science in the subdivision of epidemiology, namely, that the epidemic colic of Devonshire, England, was due to an obscure poisoning by lead conveyed through the common cider used for drinking in that district. In 1774 the foundations of state hygiene and sanitation were laid in consequence of the patient investigations and startling revelations of John Howard, by an act of Parliament providing for the sanitation of jails and prisons. The beginnings of marine hygiene and sanitation appear in 1776, when Capt. Cook, the navigator, was awarded the Copley medal of the Royal Society for his remarkable success in protecting the lives of his sailors on his second voyage. In 1796 Edward Jenner, working also in a strictly scientific manner, and employing the methods of rigid inductive research, laid securely for all time the foundations of personal hygiene and immunization, by showing how we can produce at will such modifications of the physiological resistance or susceptibility of the human body as to make it immune to smallpox.

We already know that certain metals have an influence either favorable or unfavorable, upon the oxidation of organic bodies. It is also found that some metals, such as copper, when placed under water which is constantly aerated and in presence of iron, cause the oxidation of the iron to increase. Other metals, much more numerous, such as tin, lead, zinc, manganese, etc., retard the oxidation like the alkaline carbonates. These phenomena are not due to the presence of the metal, but to the solution in the water of traces of hydrates of their oxides, and M. Lindet, who made some experiments to bring out these facts, shows this by running a stream of air through water where copper or zinc had been placed, along with iron which was left in the liquid. Among the bodies which prevent the oxidation of iron we may cite arsenic and its compounds in the first rank. Arsenic in the presence of aerated water gives arsenious acid and perhaps sub-oxide of arsenic. Sometimes this element, when it is in large proportion, completely stops the oxidation of the iron. Often it only slows it up. In this case the iron dissolves, especially at a high temperature, and gives ferrous arsenite, then ferric arsenite, containing a quantity of oxide of iron which does not exceed one-third of what is formed under the usual conditions of oxidation. These arsenites are colloidal and are not thrown down by potash in which they dissolve, nor by ammonia. Arsenic acid quite stops the oxidation, and also the alkaline arsenites and arseniates, when used in about 1 per cent proportion. On the contrary, some salts cause iron to oxidize more rapidly—the soluble salts, chloride of sodium or potassium; the sulphates of these metals make the oxidation two or three times as rapid, owing to their electrolytic dissociation. The action of organic bodies is no less striking. Sugar, phenol, resorcin, etc., accelerate the formation of rust on iron, while it is retarded by alcohol, methyl salicylate, etc. Acetic acid and others dissolve the iron when it rusts.

ENGINEERING NOTES.

One suburb of Cleveland containing large steel works has been redeemed in the most remarkable manner by the introduction of automatic stokers, so that there is now a place for human beings to live, where formerly all was soot and blackness. The president of a manufacturing company using four stokers reports that he is not only paying from fifty to seventy-five cents less per ton for his fuel, but is burning six tons less per day than formerly, and at the same time getting better satisfaction in the maintaining of a uniform steam pressure. It is undoubtedly true that the agents of smoke-abating devices of all sorts have been extravagant in their claims and that they have damaged their own business by such claims, but this is a mistake not confined to the furnace business. A conservative claim of from ten to twenty per cent saving, depending upon how smoky the furnace has been, can usually be substantiated by a comparison of the coal bills before and after introducing stokers, without resorting to expert tests.

Whenever for any sufficient reason the stoker can not be introduced, there are other devices which will mitigate the smoke nuisance considerably and also save fuel. The steam and air blast has already been mentioned. A recent improvement which promises well is the combination of steam jets at the bridge wall with oil vapor, creating an intense heat at that point and consuming the hydrocarbons as they pass through. The expenditure of oil is comparatively small and considerable economy is said to result. Brick arches and baffle walls have also assisted in maintaining a high temperature and in properly mixing the gases. The use of a reverberatory furnace or outside oven in which the coal and its gases are thoroughly burned before going to the boiler is another satisfactory method of reducing smoke, and may be used as well with as without a stoker. In short, whatever produces good combustion abates smoke. In apartment houses and stores where the boilers are used for heating only and the steam pressure is low, the use of fuels which are comparatively smokeless is about the only satisfactory solution.

An interesting feature in regard to compound centrifugal pumps is the requirement to discharge a given quantity of water to a desirable height, and then twice the quantity of water to practically one-half of the original height without changing the speed of the pump. This requirement is met with in barometric condensers where it is required to discharge sufficient water over the top of an inverted syphon to start the siphon, and then, having started the siphon and receiving the benefit of its action, to supply at least double the amount of water to the lower head required when the siphon is in action. This is accomplished by placing two centrifugal pump impellers back to back, providing each with its own suction and discharge passages, but also providing a passage by which one impeller may discharge into the suction of the second impeller, and further providing valves by which the independent discharge of the first impeller may be cut off and *it* forced to discharge through the second impeller, and the supply of the second impeller cut off and *it* forced to take the discharge of the first impeller, by which arrangement the two impellers may be run in parallel or series, as may be desired.

A grate or stoker should supply the required amounts of fuel and air, and in such relative proportions as to cause a proper balancing of the quantities of air and combustible, or should be so designed and proportioned as to insure such result by proper manipulation, and sufficient mixture between fuel and air should occur at the grate so as not to overtax the mixing capacity of the furnace. In addition, this portion of the apparatus should remove the ash in a manner and at a rate so as not to interfere with fuel and air supply, and at the same time not waste fuel in the ashes. Thus it appears that the function of the grate or stoker is complicated. The plain hand-fired grate fulfills requirements to a minimum, while on the other hand a properly proportioned chain grate stoker fulfills requirements to a maximum extent. It is not only desirable that the grate or stoker utilize the entire amount of fuel, but that it furnish a product suited to the requirements of the furnace, so that it in turn may be able to serve the boiler with a product best adapted to its especial needs. Therefore it is important and necessary that the individuality of the functions and processes be recognized, because a high efficiency cannot be had from a good boiler if served with a poor fire, or from a good fire if the heat absorption is attempted with a poor boiler.

Much interest has been felt in different parts of the country in the use of oil for treating the surfaces of highways, in order to lay the dust and to offer a hard, impervious, waterproof surface. It is well known that in California such treatment of roads has met with a high degree of success. Similar experiments, however, when carried out in the East, proved complete failures; the eastern oil failed to bind on the surface of the road, and did not lead to the desired result. When it was found that the main difference between the California natural oils and the eastern and Texas oils lay in the fact that the California oils contained an asphalt base, while the eastern oils contained a petroleum or vaseline base, the Division of Tests of the Department of Agriculture immediately suggested that the cause of the failure of previous eastern experiments was directly due to this fact, and road builders throughout the country were urged to make experiments with mixtures of crude oils with crude asphaltum. Last summer the Commissioners of the District of Columbia consented to make such an experiment. A street in Washington was selected for the purpose and a number of mixtures of southern crude oil and asphaltum were spread in adjacent sections. At first the experiment was looked upon as a failure, but the road has been steadily improving, and at present there is every promise of the experiment's proving a success. If it proves true that mixtures of eastern crude oil and asphaltum make as good roads as the California oils do, a very great advance will be made toward the betterment of our rural highways.

ELECTRICAL NOTES.

Action of Heat and of the Electric Effluvium on Gases.—In recent memoirs presented to the Académie des Sciences, M. Berthelot has given the results of experiments which throw a new light on the comparative rôles of heat and of electricity in determining combinations and decompositions. He has reached conclusions differing from those of certain eminent chemists who have studied the conditions of chemical combination by the employment of a metallic tube kept at a low temperature by a circulation of air and placed within a large earthen or porcelain tube heated to a high temperature, the difference of the temperatures being one thousand three hundred degrees C. He gives the details of various experiments with elements and compounds. At the ordinary temperature the effluvium yields a notable quantity of ammonia. But under the high temperature produced by the electric spark, the ammonia is decomposed, so that its formation cannot take place, except at a low temperature. This explains why only small quantities of the gas are met with. Neither hydrochloric acid nor carbonic acid is dissociated by a temperature of 1,300 deg. C. The reported phenomena of dissociation in the work of blast furnaces are, in his opinion, extremely doubtful.

Railway Signals.—The manipulation of distance electric signals on railways by one and the same conductor, by means of the lowering of a single key and the simultaneous action of an induction coil, is not perfectly sure. When the handle of the inductor is not moved with care, the signal may, for example, pass from the position "open circuit" to that of "closed circuit," resuming immediately afterward the position "open circuit." The Zeitschrift für Electrotechnik reports that an Austrian engineer, Herr Krupie, has succeeded in overcoming this difficulty by rendering the two positions of the distance signal independent of each other. For this purpose he uses two keys and two conductors, with an earthed wire. In his system, when the induction coil is worked and one of the keys lowered, an electric bell is heard and indicates that the electric signal is in operation. As soon as the signal has taken the desired position, the magneto-electric bell is automatically silenced, notwithstanding any new manipulation of the inductor or depression of the key. A cylindrical contact arranged in connection with the signal clockwork is for this purpose constructed in such a way that the friction springs which are brought against it interrupt the induction current in each of the two cases of "open circuit" and of "closed circuit" just before the desired normal position is reached, so that there is no occasion to fear that the signal will take a dangerous intermediate position, or regain its preceding position. The absence of current is absolute when the signal occupies either of the two normal positions. In consequence, accidental confusion in the choice of levers which are solidly connected together, has no effect on the position given to the signal.

From the dawn of electric telegraphy, inventors have been at work filling the patent records with printing telegraph schemes, some brilliant, some stupid, and nearly all useless. Out of several hundreds of printing telegraphs invented prior to the beginning of the twentieth century, only the Hughes and the Baudot and the stock tickers achieved any real success. With the stock-tickers the problem to be solved was comparatively easy. They are only required to work over distances of a few miles. High speed was desirable, but not absolutely necessary. One man, by playing on a keyboard, could transmit messages to a considerable number of subscribers, and there was no necessity to deliver the messages, no need to count the number of words in each message, to sign and time the messages, or to cut up the tape and paste it on telegraph blanks, no need to keep copies of the messages for record, or to put them in envelopes and address the envelopes and send them out by messengers. The conditions were of the simplest character, and the consequence has been that the stock-tickers long ago reached their full development. As for the Hughes, of which about 3,000 are in use on the continent of Europe, it may be best described as a glorified stock-ticker for working over comparatively long distances. It prints on a tape and the speed is limited by the manual dexterity of the operator at the keyboard. The gain compared with the Morse key is small. The Baudot printing telegraph, which is largely used in France, and which connects Paris with nearly all the European capitals, may be described as a multiplied Hughes, as it is equivalent to four and even six Hughes instruments working over a single wire. It is exceedingly ingenious, highly practical, and gives admirable service within its limitations; but it is not a fully developed printing telegraph system, because it is not provided with a typewriter keyboard for transmitting, and it does not print the messages in page form. It prints on a tape, and it does not save labor to an appreciable extent compared with the Morse key. Its great virtue is that it saves wire. The Morse quadruplex and the Baudot might be described as the second stage in the development of the modern telegraph. The third and final stage of completely developed machine telegraphy has only been reached during the past five years.

TRADE NOTES AND RECIPES.

Method for Preserving Fruits and Vegetables.—Tests made by the French agricultural associations have shown that powdered cork is very efficacious for packing and preserving fruits and vegetables. A bed of cork is placed at the bottom of the case, and the fruits or vegetables and the cork are then disposed in alternate layers, a final one of cork coming at the top. Care should be taken to fill up the interstices, in order to prevent friction. Fruit may thus be kept fresh a year, provided any unsound parts have been removed preliminarily. When unpacking for sale, it suffices to plunge the fruit into water. Generally speaking, 20 kilos of cork go with 400 or 500 kilos of fruit. The cork serves as a protection against cold, heat, and humidity. Also, in Spain various fruits, such as grapes, mandarines, tomatoes, and early vegetables, are successfully packed in this way.

New Non-alcoholic Beverages.—The German commercial publication Handelsmuseum records a movement among German chemists for the production of new hygienic beverages, possessing all the stimulating properties of wine and beer, but without alcohol. The constituent elements of these drinks are not yet made public, but the Handelsmuseum intimates that an innovation so important would revolutionize the liquor trade. The chemists engaged in the undertaking aim at enabling the temperance societies to attain their ends. It is proposed to make the synthesis of wine and beer, and to study the constituent elements of their nature and their relations to the organs of taste; it will then be sought to produce upon these organs action analogous to that produced by alcohol. It is asserted that synthetic chemistry has succeeded in reproducing the ethers of fruit without having recourse to any vegetable substance. But in this case not artificial, but only natural ethers, would be brought into play.

Production of Artificial Cotton.—According to the Bulletin of the French Chamber of Commerce at Milan, good results have been attained in the production of artificial cotton extracted from fir and freed from bark and knots. A special machine breaks up the fibers, which are placed in a copper, lead-lined cylinder 100 cubic centimeters in capacity. Steam is introduced for ten hours by means of a pipe in the bottom; then 60 cubic centimeters of soda lye are poured in and boiled for 36 hours under a pressure of three atmospheres. The material is washed, crushed more thoroughly, bleached and dried by means of rollers. The pure cellulose thus obtained is heated in an autoclave containing a mixture of zinc chloride, chlorhydric acid and nitric acid, to which a little castor oil, caseine and glycerine is added. After further manipulation for reducing the fiber, it is passed through a weak solution of carbonate of soda and then between drying rollers. To give the necessary firmness to the thread, it is finally put into a bath of diluted ammonia and then washed with cold water. It may be easily woven and dyed. In Bavaria, experiments for producing cotton from pinewood have succeeded. When the artificial product is compared with the natural, it is difficult to distinguish the difference, and it is even asserted that the former may be produced so economically as to be able to compete with the latter.

Increase in the Coefficient of Safety in Explosives.—Ammoniacal salts have been used in the manufacture of explosives to render them proof against firedamp, but not with the full success desired. So, ammonium chloride has been utilized, but still inconveniences are met with, and the vapor is quite disagreeable. However, in co-operation with equivalent quantities of soda and potash, its action is regarded by M. Bichel, a French investigator, as exceedingly favorable. He has made various tests, employing benzine vapor and coaldust, and regards the following formulæ as effective for the purpose, the comparative security being represented by the figures given.

1. Donarite, composed as follows: 80 per cent of nitrate of ammonia, 12 of trinitrotoluol, 4 of flour, 3.8 of nitroglycerine, and 0.2 per cent of cotton collodion. Security: Donarite alone, 87 grammes; 95 per cent of donarite and 5 per cent of ammonium chloride, 125 grammes; 90 per cent of donarite and 10 per cent of ammonium chloride, 250 grammes; 86 per cent of donarite and 5.5 per cent of ammonium chloride, with 8.5 per cent of nitrate of soda, 425 grammes. The force of the explosion is decreased about 8 per cent, while the security is quintupled.

2. Roburite, with the following composition: 72.5 per cent nitrate of ammonia; 12 binitro-benzol, 10 nitrate of potash, 5 sulphate of ammonia, 0.5 per cent permanganate of potash. Security: Roburite only, 325 grammes; ammonium chloride, taking the place of sulphate of ammonia, 400 grammes. Here an intensification of the explosive force is simultaneously produced.

3. Ammon-carbonite I, composed thus: 4 per cent nitroglycerine; 75.5 nitrate of ammonia; 9.5 nitrate of potash; 9.5 coal-dust; 10.5 flour. Security: Ammon-carbonite I only, 250 grammes; 95 per cent A. C. I. and 5 per cent ammonium chloride, 400 grammes; 92 per cent A. C. I. and 8 per cent ammonium chloride, 500 grammes. The addition of 5 per cent ammonium chloride diminishes the explosive force only 3 per cent.

4. An explosive of nitroglycerine base composed thus: 30 per cent nitroglycerine; 1 per cent cotton collodion; 52.6 nitrate of ammonia; 13 nitrate of potash; 3 to 4 per cent starch. Security of this mixture, 150 grammes.

Another mixture: 30 per cent nitroglycerine; 1 per cent cotton collodion; 47.3 nitrate of ammonia; 11.6 nitrate of potash; 3.1 starch; 7 per cent ammonium chloride. This mixture has a security of 350 grammes.

JUST PUBLISHED

American Tool Making and Interchangeable Manufacturing

By JOSEPH V. WOODWORTH

THIS book is a complete practical treatise on the Art of American Tool Making and System of Interchangeable Manufacturing as carried on to-day in the United States. In it are described and illustrated all of the different types and classes of small Tools, Fixtures, Devices and Special Appliances which are, or should be, in general use in all machine manufacturing and metal working establishments where economy, capacity and interchangeability in the production of machined metal parts are imperative.

All of the tools, fixtures and devices illustrated and described have been, or are, used for the actual production of work, such as parts of Drill Presses, Lathes, Patented Machinery, Typewriters, Electrical Apparatus, Mechanical Appliances, Brass Goods, Composition Parts, Mould Products, Sheet Metal Articles, Drop Forging, Jewelry, Watches, Metals, Coins, etc.

The treatment of each tool described and illustrated is such as to enable any Practical Man to Design, Construct and Use Special Tools, Dies and Fixtures, for the Rapid and Accurate Production of Metal Parts Interchangeably.

To the Machinist, Tool Maker, Designer, Die Maker, Superintendent, Manager and Shop Proprietor this book shows the 20th Century Manufacturing Methods and Assists in Reducing the Expense and Increasing the Output and the Income. A book on the System of Interchangeable Manufacturing—The System that has Won for the United States the Industrial Supremacy of the World.

535 Pages Bound in Cloth 600 Illustrations

PRICE $4.00

MUNN & CO., Publishers

SCIENTIFIC AMERICAN OFFICE

361 BROADWAY - - NEW YORK

TWENTY-THIRD EDITION

EXPERIMENTAL SCIENCE

By GEORGE M. HOPKINS

Revised and Greatly Enlarged. 2 Octavo Volumes. 1,100 Pages. 900 Illustrations. Cloth Bound, Postpaid, $5.00. Half Morocco, Postpaid, $7.00. Or Volumes Sold Separately: Cloth, $3.00 per Volume. Half Morocco, $4.00 per Volume.

EXPERIMENTAL SCIENCE is so well known to many of our readers that it is hardly necessary now to give a description of this work. Mr. Hopkins decided some months ago that it would be necessary to prepare a new edition of this work in order that the many wonderful discoveries of modern times might be fully described in its pages. Since the last edition was published, wonderful developments in wireless telegraphy, for example, have been made. It was necessary therefore that a good deal of new matter should be added to the work in order to make it thoroughly up-to date, and with this object in view some 200 pages have been added. On account of the increased size of the work, it has been necessary to divide it into two volumes handsomely bound in buckram.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. AUTOMOBILES.—Automobile Lawn Mowers.—2 illustrations.... 24692
The Winning Automobiles in the Sixth International Cup Race for the Bennett Trophy.—9 illustrations 24696

II. CIVIL ENGINEERING.—Extending the Santa Fé Railroad into San Francisco.—By HERBERT I. BENNETT.—8 illustrations.... 24685

III. ELECTRICITY.—A New Recording Voltmeter for Both Direct and Alternating Current.—1 illustration..... 24693
Auto-starter for a 1,400 Horse-power Induction Motor.—1 illustration..... 24693
Electrical Notes..... 24699
The Evolution of the Telephone.—By W. H. SHARP..... 24694
Contemporary Electrical Science..... 24698

IV. ENGINEERING.—Engineering Notes..... 24699

V. MECHANICAL ENGINEERING.—Theatrical Engineering—Past and Present.—I.—By CARL LAUTENSCHLAEGER..... 24676
The "Dey" Time Register.—By EMILE GUARINI.—2 illustrations 24689
The Schlick Pallograph.—19 illustrations..... 24688

VI. MISCELLANEOUS.—How Food Imports Are Inspected..... 24695
Science Notes..... 24699
The Scientific Incongruities and Anachronisms of Artists.—By T. C. HEPWORTH..... 24690
Trade Notes and Recipes..... 24700
Anchor Ice: What it is..... 24697

VII.—PHOTOGRAPHY.—Recent Progress in Photography.—By Dr. LUDWIG GUENTHER..... 24692

VIII. PHYSICS.—The Emission of N-Rays by Odorous Substances and the Action of N-Rays on the Olfactory and Other Senses.. 24691
The Temperature of Flames..... 24691

Home Mechanics for Amateurs

This book has achieved an unparalleled success in one week, and a Special Edition of 4,000 copies has been ordered. It is by far the largest and best book on the subject ever offered at such a low price. It tells how to make things the right way—the "only" way—at small expense. It will prove of value to you—much more than you realize. Do things with your hands. Send for a circular giving contents—the circulars cost only a cent—the book $1.50 postpaid. If the book could meet you face to face you would be the first to purchase. The first large edition is almost gone. Order to-day.

370 Pages 326 Engravings Price $1.50

LATEST EDITION
.. OF ..
Supplement Catalogue
JUST OUT!

Write for it. It costs nothing.

The new Catalogue contains 65 pages and gives a list of over 17,000 articles.

If there is any scientific, mechanical or engineering subject on which you wish special information, you will find in this Catalogue some papers in which it is thoroughly discussed by a competent authority.

SCIENTIFIC AMERICAN SUPPLEMENT papers for the most part have been written by the world's most eminent engineers and scientists. They contain information that is not always accessible in books.

MUNN & COMPANY, PUBLISHERS
361 BROADWAY NEW YORK CITY